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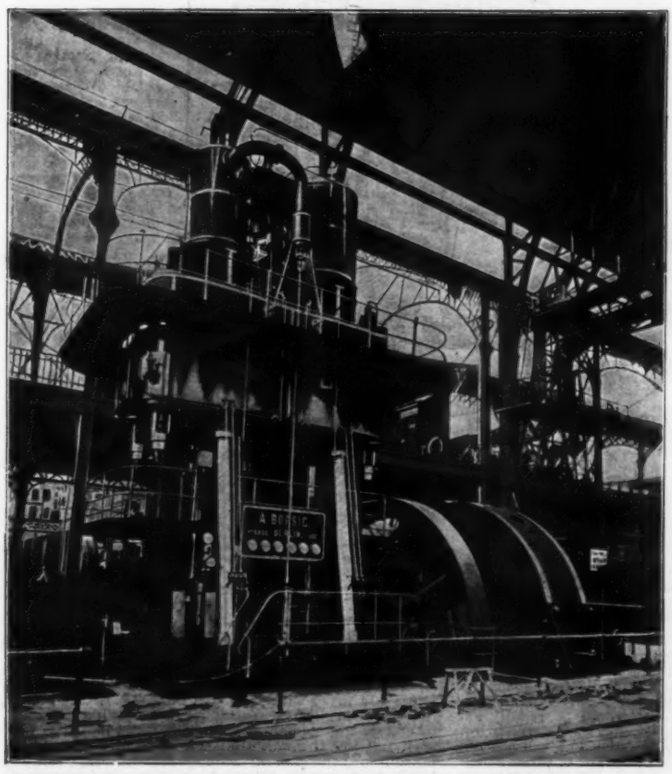
THE POWER-GENERATING PLANT AT THE PARIS EXPOSITION.

IN our last issue we described the Electrical Building and the Chateau d'Eau, and in the present we take up the power-generating plant.

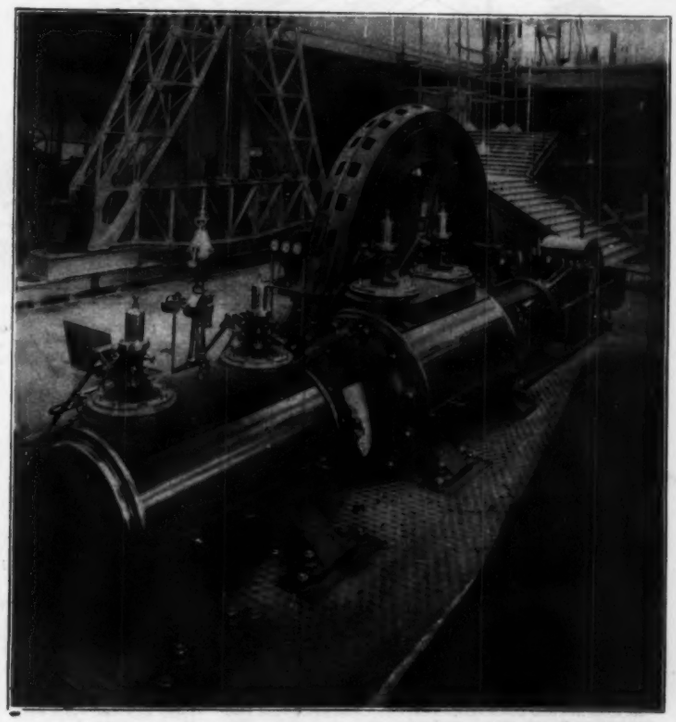
On account of the natural adoption of electrical power transmission for the Paris Exposition, it has been possible to concentrate the whole of the power plant for the main buildings in two central stations under the roof of the Electricity Building. These are known by the names of the streets which bound the Champ de Mars on the east and west, as the Bourdonnais station and the Suffren station; also by the designation of French and foreign stations, respectively, as in one case both boilers and generating machinery are furnished by French manufacturers, and in the other by exhibitors from different countries. These two stations are entirely distinct, one from the other, with separate systems of boiler-flues leading to ornamental chimneys; but a complete arrangement of underground steam and water mains unites them. The boiler-rooms are located between the old Galerie des Machines and the new Palace of Electricity, in which are installed the large direct-connected engines and dynamos which furnish current for distribution of light and power throughout the Exposition grounds. The boiler-rooms are built with open sides and a steel frame roof, covered with corrugated iron with a glass skylight, leaving a clear space next to the adjoining buildings of about 18 feet, and conforming thereby to the French law, which regulates the use of boilers in proximity to inhabited buildings, under which category the Exposition structures are included. This space is used, however, for the passage of cars conveying coal or removing ashes, for storage of coal, and as a means of circulation. It is of interest to note that such care is taken to avoid the flying in the air of dust or ashes that both coal and ashes are required to be handled in sacks for transportation within the Exposition precincts, and all such work must be concluded before eight o'clock in the morning.

AUGSBURG ENGINE DRIVING A HELIOS ALTERNATING-CURRENT GENERATOR.

Each boiler room covers an area 344 feet long and 92 feet wide, the clear height at the center being 24 feet 7 inches; and the boilers are arranged in two rows, back to back, the lines of fronts being kept straight. The engines to be supplied from these boilers being of about 36,000 horse power, a steam capacity of about 518,000 pounds per hour has been provided, the Bourdonnais station supplying slightly more than one-half of this amount. The maximum demand is considered as not exceeding 440,000 pounds per hour, leaving a margin of 78,000 pounds, which will assure an uninterrupted service, even though some boilers are disconnected for cleaning or repairs. One day a month is allowed each boiler for cleaning, this being judged



BORSIG ENGINE AND SIEMENS & HALSKE GENERATOR.



CAREL'S ENGINE DRIVING KOLBEN ALTERNATOR.

sufficient by the administration authorities, who have taken the precaution of requiring that no type of boiler shall be admitted which has not already stood the test of practical use under the ordinary outside conditions of everyday working.

There are ninety-two boilers in the two stations, most of which are of the water-tube type; a few are of the Lancashire or Cornish internal fire-tube type. The total heating surface of the boilers is approximately 160,000 square feet, which, considering a maximum steam production of 518,000 pounds per hour, gives an average of 3·2 pounds of steam per hour per square foot of heating surface. The steaming power varies between the limits of 4·73 pounds per hour per square foot with a ratio of heating surface to grate area of 24·1 and 2·056 pounds with a ratio of 55·1. The total grate area is 4,240 square feet, giving a steam production of 122 pounds per hour per square foot. The average steaming capacity of the boilers, individually, is about 5,600 pounds per hour, but this figure is doubled in the case of a boiler by Mathot, a French manufacturer, who also intends to supply a boiler of one-half the average capacity. These exhibits are, however, not yet on the ground. Three of the largest exhibitors are represented in both stations: the Babcock-Wilcox Company, of Paris; J. & A. Niclausse, of Paris; and De Naeyer & Company, of Willebroeck, all furnishing water-tube boilers and providing nearly one-half the capacity of the whole plant. The Mathot Company also exhibits in both sections.

The semi-tubular boilers of the company of Fives-Lille are made with two water-cylinders below, each connected by three water-legs with a single upper boiler provided with fire-tubes for return of the hot gases. The Cornwall type of boiler, so designated in the official publications, is in reality of three distinct styles. Paucksch has one internal fire-tube; Petzold and Bernighaus have two, with superimposed fire-tube boilers, while a special boiler by the last named manufacturer has three internal fire-tubes.

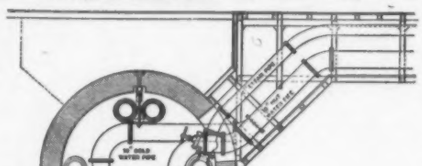
The steam pressure at the boilers is to be 156 pounds per square inch, and at the engines 140 pounds. The boilers feed into two sets of 10-inch steam mains carried one above the other on the framework supporting the roof; and cross connections between the lines on each side are made, bringing the steam to two equalizing-cylinders about 28 inches in diameter and 10 feet long, situated 120 feet apart. From each of these cylinders four 10-inch pipes convey the steam through large brick tunnels to the engine room.

Feed-water for the boilers is supplied by the administration of the Exposition, the upper basin of the Château d'Eau—the great fountain in the Champ de Mars—being used as a reservoir from which water is brought to the two lines of boilers in each station, by means of a 14-inch main, feeding into a 10 inch cross line, and terminating in two cast-iron 8-inch pipes. Outlets are provided at convenient points where exhibitors are required to make connections to their pumps at their own expense, using 2½-inch pipe.

The main smoke-flues and the chimneys have been built by the Exposition administration, but the communicating flues from the boilers are put in at the expense of the exhibitors. All the construction is underground, in two divisions 300 feet long, passing through the length of the boiler-room and curving outward to right and left at a distance of 62 feet from the chimney, to enter the base at diametrically opposite points. In order to avoid encroaching upon the foundations of the boilers, the increase in size of consecutive sections of the flues is downward, thus preserving a uniform total width, after the first section, of 27 feet. The first section in each division consists of a vaulted brick tunnel 6 feet 6 inches high and 3 feet 10 inches wide. The sides, forming the abutments of the arch, are brought up to the level of the top of the arch, in order to form a secure foundation for the railroad tracks passing down the center of the space, and to support the rear ends of any boilers extending so far toward the center.

In order to promote a good draught through the flues and chimney, the individual flues from the boiler groups are curved at the point where they enter the main flues.

Each station has a large ornamental chimney at the side toward the street, one near Avenue de la Bourdonnais and one near Avenue de Suffren. The height in each case is 80 meters (262 feet 6 inches) above the ground, the internal diameter at the top is 14 feet 9 inches, and at the base 20 feet 4 inches. The outside



SHOWING METHOD OF RUNNING CONNECTIONS FROM ENGINES TO TUNNEL-MAINS.

diameter at the base, on the ground level, is nearly 40 feet, and at the lowest point, 21 feet below ground, the foundation is 59 feet in diameter. The excavation was carried to this depth in order to reach firm soil, as the ground of Champ de Mars has so frequently been disturbed within the last thirty years. Below a stratum of sand, clay was found, of high resisting quality, and to insure thorough stability a further foundation of 133 piles was used, these being driven till the blows ceased to have appreciable effect. The piles were then cut down to a uniform height of about 3 feet above the level of the floor of the excavation, and the whole covered with a bed of concrete 5 feet in thickness, upon which the chimney was subsequently built.

In the interior of the chimney are bars, spaced at every fifth row of bricks, for ascending. As a matter of precaution and to allow of resting during the ascent, a second series of bars encircles the first, forming a sort of cage through which a man can mount with much greater measure of safety than by a single line. The ornamentation of the chimneys is quite elaborate, but not overdone, as a considerable portion of the shaft is left plain. All the decoration is effected by the use of fancy brick and ceramic designs. The Bourdonnais chimney was built by Nicou & DeMarigny, and the Suffren chimney by Toisoul & Fradet.

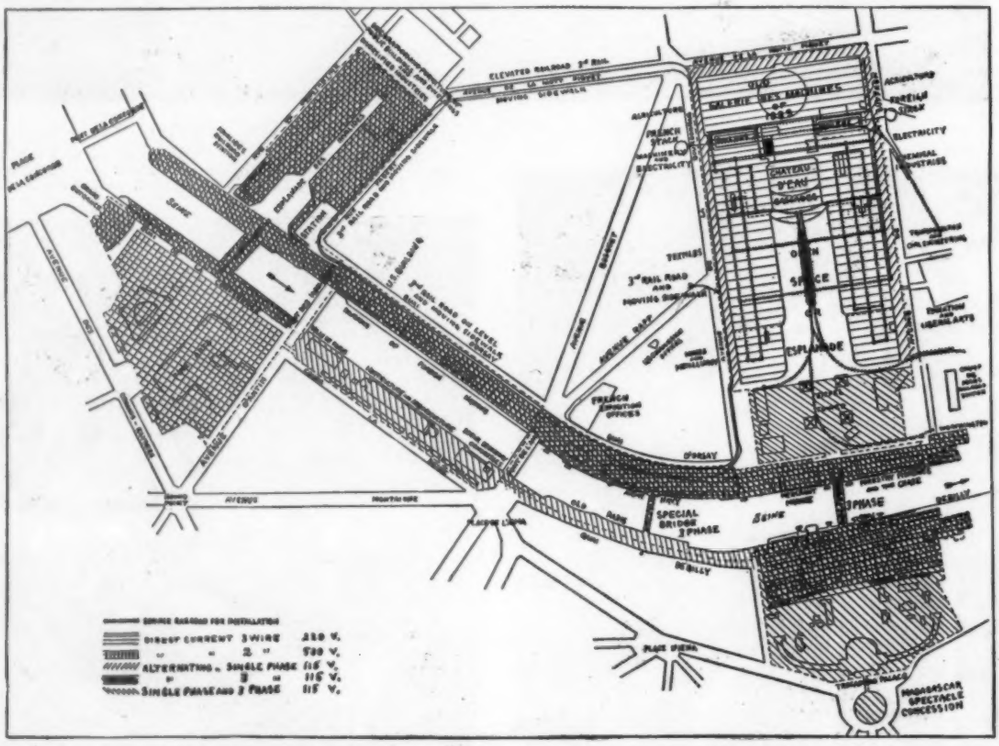
Owing to the large number of pipes required for distribution of steam and water in the machinery section of the Champ de Mars, it was necessary to employ an underground service. The most practicable method of accomplishing this was to provide subterranean passages or tunnels, where all pipes would be readily accessible for inspection or repairs, and such a system, on a liberal scale, has been carried out. The tunnels are built in three sizes, according to the size of pipes which they are intended to accommodate. No. 1 is 8 feet 6 inches wide, 8 feet 10 inches high, and 1,709 feet long; No. 2 is 7 feet 10 inches wide, 8 feet 6 inches high, and 2,400 feet long; No. 3 is 6 feet 6 inches wide, 8 feet 6 inches high, and 660 feet long. In addition to these tunnels there are drainage tunnels, carrying no pipes, which take the overflow from both sides of the system at Avenue de la Bourdonnais and Avenue Suffren into the city sewers.

The various requirements for the tunnels are to provide for the distribution of water at low pressure for purposes of condensation, this water being taken from the lower basin of the Château d'Eau; for returning to the river the warm water from the condensers; for carrying steam to the engines in the two power houses and to various smaller machines in the vicinity and for distribution of feed water for the boilers. The largest form of tunnel is intended to carry the large water pipes, 31 inches in diameter, which draw the condensing water from the lower basin and return it, after use, to the Seine. This size is also used for the main artery uniting the stations of Bourdonnais and Suffren, and passing between the boiler and engine rooms. The water pipes are laid on masonry supports in the lower portion of the tunnels, and steam pipes are carried on a second and higher step of the wall nearer the side of the tunnel, supported on rollers in order to provide for expansion. Some of the large engines being likely to require more steam than a single 10-inch pipe could supply, additional supports for pipes of the same size are provided along the roof, which are also available for the suspension of feed-water pipes.

The second size of tunnel is used for the double branchings from the main above mentioned, and is built beneath the floor of the Chemical Industries and Mechanics sections, constituting the greater part of the subterranean passageway. The condenser water supply is here carried by 24-inch pipes, and in the sub-branches of these buildings by 20-inch pipes, and in one case 16-inch. All steam pipes remain 10 inches in diameter. The smallest size of tunnel, No. 3, allows the installation of 20-inch pipes for the condenser service, as well as the steam pipes on the upper level. This size is used only to serve machines in the central halls between the two boiler rooms. At those points where the tunnels cross each other, square chambers are built, 15 feet 9 inches long on each side, and extending up to the ground level from the tunnel floor.

The steam piping is divided into sections of about 100 feet, connected by expansion joints. These consist of a bronze sleeve bolted in the usual manner to the steam pipe flange and sliding within a stuffing box with bronze wearing parts fitted to a cast iron cylinder, which in its turn is fitted to the next length of pipe. The joints between pipe lengths are made by forcing a short double-tapered cylindrical ring into the ends of the pipes and drawing the joint up close by means of bolts through the flanges. This method is also used in securing the tubes of the De Naeyer boilers, and it is said to give steam-tight joints under high pressure, dispensing with packing, and to necessitate fewer bolts.

Condensation in the steam pipes is drawn off through automatic separators or drains, which allow the water to pass through a valve which is closed when the hotter steam begins to escape. Special siphon chambers force this water into drain pipes suspended from the roof. These separators are located in the square chambers already mentioned, and in some cases the expansion joints are fitted with drainage outlets. In the boiler rooms, reservoirs are placed in each ventilating shaft to collect the condensation, which flows in at the top after passing through the separators, and out at the bottom into the general drainage system. An overflow is provided near the inlet, whence the water in case of stoppage of the lower outlet, falls to the tunnel floor.



PLAN OF EXPOSITION GROUNDS, SHOWING CURRENT-DISTRIBUTION.

The tunnels are, however, graded, so that in the event of a serious leak in a pipe the water would run through into the sewers and no interruption in power service would result.

The water in the Château d'Eau, at the end of the Champ de Mars, is pumped up from the Seine, at the other end of the Champ de Mars, by Worthington pumping machinery, and is delivered to the fountains through two 30-inch pipes. The Worthington Company put up a special building to receive its pumps, and not content with designing these, the company's engineer, Mr. Marechal, also designed the building. The construction is remarkable in its lightness and strength, for, although a steel structure, there is not a single piece in its design which cannot be handled by one man, and the total weight of steel is only about 60 or 70 tons. The pumps are arranged in two groups of two machines each. The first requirement of the Exposition authorities was the delivery of 20,000,000 gallons of water per day; but this was subsequently changed to 30,000,000 gallons. However, there is a capacity of more than 40,000,000 gallons in the present plant. The pumps are required to operate from 9:30 in the morning to 12, and from 1:30 to 5:30 in the afternoon; also from dusk or the time of illumination to the closing hour. The engines in the power house are supposed to be in readiness to run at 10 o'clock A. M.

The engines which drive the dynamos furnishing power and light for the Exposition are placed in two groups, close to the boiler rooms. At the extreme end of the Suffren station is the German section, containing four large units, all ready to move, but still lacking steam and water. The terraces of the Chateau d'Eau have been responsible in great measure for the delay. At the present writing the British engines are still missing. Some of the French manufacturers are ready, but in general they are much behindhand, and the greater proportion are still building.

There are 18 engines in the Bourdonnais station and in the Suffren station there are 19. The large German machines raise the average horse power per unit to a much higher figure than the French station can show; but the foreign engines are in general of higher output individually. Several French engine builders make use of the single cylinder construction, so that they cannot use steam at the standard pressure of 140 pounds, and have to use reducing valves. On the other hand, the German builders use triple expansion, and intend their engines for use with steam at 200 pounds to the square inch.

The first of the group of German machines is a vertical engine by Borsig, of Berlin, built to give 3,000 horse power at 85 r.p.m. with steam at 200 pounds per square inch; running, however, at 88·5 r.p.m. with 140 pounds steam pressure, the output is given as 2,500 horse power. The high pressure cylinder has a diameter of 30 inches, the intermediate 46½ inches, and the two low pressure cylinders each 52¾ inches. The stroke is 47¼ inches. Two cranks are used, placed at 180 degrees. At one end of the shaft is the dynamo, built by Siemens & Halske, of Berlin, giving three-phase currents at 2,200 volts. The armature, which is stationary, surrounds the revolving field, and is carried on a circular frame so arranged that it may be turned on its roller supports, should trouble develop in an otherwise rather inaccessible part of the winding. The adjustment of the air gap is obtained by slight changes in the positions of the supports below, and the frame may be firmly locked by means of bolts passing through the cradles at the sides. The exciter is an 8-pole machine, giving 214 amperes at 210 volts, at 88·5 r.p.m. As a higher-speed machine, running at 340 r.p.m. the output reaches 200 kilowatts.

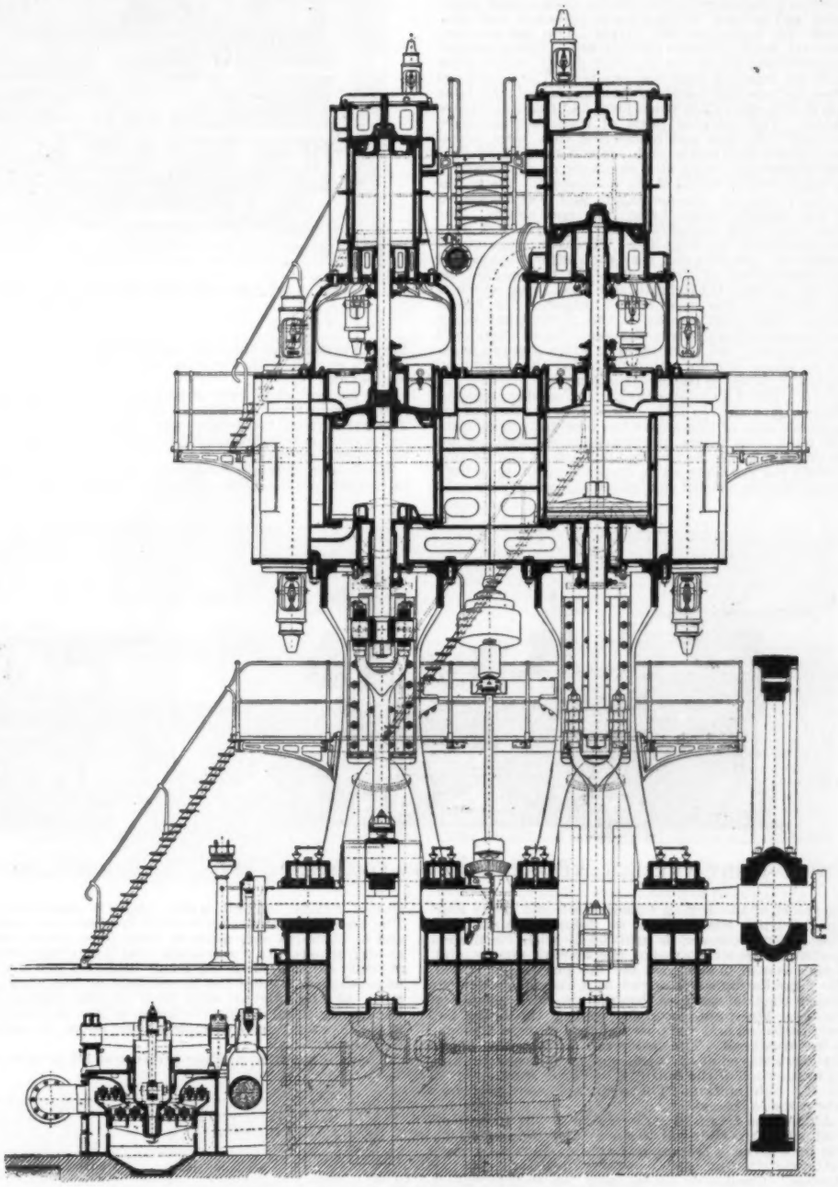
The second German engine and generator set is built by the Nuremberg Engine Company and Schuckert & Co. This if also a vertical engine of 2,000 horse power, triple expansion, having at one end of the shaft a direct-current dynamo giving 800 kilowatts at 500 volts, and at the other end a 3-phase 850-kilowatt alternator furnishing current at 5,000 volts. The stroke of the engine is about 43 inches, and the cylinders are 30½ inches, 48¾ inches, and 71 inches in diameter, only three cylinders being used. The speed is 83 r.p.m. This engine is intended for the central station at Essen-on-the-Ruhe, to furnish light and power. The weight, complete, is 530,000 pounds.

Another vertical engine, compound, of 1,400 horse power, is shown by the Nuremberg & Augsburg Consolidated Engine Company, direct coupled on one side to a 790-kilowatt three-phase generator, giving 5,000 volts, and on the other side to a direct-current 350 kilowatt 500-volt machine, built by the Lahmeyer Electric Company. The speed is 94 r.p.m., and the weight 265,000 pounds. In the Belgian section this engine builder has a triple-expansion vertical engine of 500 horse power coupled to a single-phase 2,000-volt alternator by the Electric and Hydraulic Society of Charleroi, but this exhibit will not be shown in operation.

The fourth engine of this group is a horizontal four cylinder triple expansion 1,900 horse power engine, by the Augsburg Engine Company, who make a specialty of this type, while the Nuremberg Engine Company builds vertical engines. The alternator is furnished by the Helios Electric Company, and supplies single-phase or three-phase currents. The special features to be observed in this engine, apart from the fact that it is the only horizontal one in the German section, are the centralized systems of control, both of the mechanical and electrical performance. Within the rectangle inclosed by the cylinders are the main steam valve, the governor, the steam-jacket valves, the main switch handle, the exciter field and generator field regulator levers, and instruments showing the exciter and generator voltages and the current output on the three lines; also gauges indicating the steam pressure in the high pressure, intermediate and low pressure cylinders, the latter having a negative scale extension of a few points to show when expansion is below atmospheric pressure. The vacuum is also indicated for the two condensers below, one on either side of the engine.

All steam pipes and connections are below the floor level; the steam inlet to the high pressure cylinder is opened by revolving a hand wheel which operates the main valve, this being always wide open during the running of the engine. If, however, it should become necessary to quickly shut off steam, this can be accomplished in a moment by pulling over a lever, which breaks the direct line of the rods actuating the high pressure valve and shuts off steam from the cylinder. Regulation of speed is obtained by a ball governor which may be accurately adjusted or changed at any time by sliding a weight along an arm by means of a screw. The air pumps for the condensers are operated by connecting rods attached to the crossheads. In order to relieve back pressure a small three-phase motor is installed below, direct-connected to a centrifugal pump, raising the water three meters to a higher level for running off.

The exciter is not mounted on the engine shaft, as is the case with the other units, but is installed a little distance away on its own foundation and is driven by a 60 horse power marine type condensing engine. This is larger than is needed for exciting the generator, but some of the power is used to light the passage-ways which extend beneath the engine. The main switch is mounted down there, on a finely finished marble board. There are three double-contact knife blades which are brought successively into contact with the clips, by turning a horizontal wheel on the engine room floor above. Immediately underneath the wheel are the two levers, to right and left, controlling the resistances to be inserted in the field circuits, these resistance coils being close to the main switchboard and cut in or out directly by the movement of the levers.



TRIPLE-EXPANSION ENGINE OF 2,500 HORSE-POWER—LONGITUDINAL SECTION.

The only engine in the foreign section, outside of the German machines, which is ready, is the horizontal engine of 1,000 horse power, built by Carels Brothers, of Ghent, driving a 500-kilowatt three-phase 3,000-volt generator, built by the Kolben Electric Company. Among the French engine builders, Delaunay-Belleville & Company are ready to run their 1,250 horse power vertical triple-expansion engine. A compound wound Breguet alternator is direct-connected, giving an output of 736 kilowatts at 250 r.p.m., the e.m.f. being 2,200 volts. The 440 horse power engine of Garnier & Faure, Beaulieu, has been ready for some weeks.

It is interesting to note that the Postel-Vinay Company, who built the generator which is direct-coupled to this engine, manufacture for the French Thomson-Houston Company, and the machine is actually a standard 8-pole 350-kilowatt traction generator, running at 90 r.p.m. The air-gap is larger than normal, and the e.m.f. is reduced to 440 volts. On the other side of the engine room the French Thomson-Houston Company is putting in a large alternator driven by a vertical engine of the type and design of the E. P. Allis Company. This machine is a long way from being ready, but promises to be one of the finest generating sets in the station.

A striking peculiarity of many of the French engines is the use of a single cylinder, as, for instance, in the case of a horizontal engine by Weyher & Richemond, in which one cylinder furnishes the whole output of 1,000 horse power. It would naturally seem that the rotation could not be very even but would show pulsations plainly.

There still remains very much to be done before the two power stations will be in full running order. Until the flooring is all down and the engine rooms quite clean, the German exhibitors are not anxious to run their engines, as the air is laden with dust and sand.

The main switchboard is still under construction, being located on the ground level of the Electricity building, behind the Château d'Eau. From this point the various sections of the Exposition grounds will be supplied with current.

The distribution of light and power is as follows:

Low-tension current is in the buildings of the Champ de Mars, for both light and power, for the interior of the Invalides Palace a two-wire 500-volt system is installed for power only. In the case of alternating current supply, the machines have been so connected to the switchboard that all those possessing the same characteristics of voltage and frequency are grouped together. The Exposition has been divided into sections corresponding to those groups, thereby assuring a continuous supply of light or power even though some machine should break down. Single-phase alternating current is distributed through the section surrounding the Champ de Mars on the outer façade, the primary being 2,000 volts and the secondary 110 volts; the frequency is 50 periods per second. Three-phase current is available during running hours of the plant in the gardens of the Champ de Mars, Trocadero and Quai Debilly, near the Trocadero, at 2,000—110 volts and a frequency of 50. During lighting hours three-phase current is available on the Quai d'Orsay, below the Alma Bridge, at the same tension, but the frequency is 42 periods per second. Above the Alma Bridge, on the Quai d'Orsay, the primary is 4,800

volts and the secondary 110 volts, and the frequency 50 periods per second. On the western side of the Invalides (rue Fabert), the primary is 4,800, or 2,000 volts, secondary 110 volts, frequency 50. On the eastern side (rue Constantine) the primary is 2,000 volts, secondary 110 volts, frequency 50.

For our engravings we are indebted to The American Electrician, as well as for our text. The diagram showing current-distribution is from The Electrical World.

[Continued from SUPPLEMENT, No. 1275, page 20433.]

AN OUTLINE OF THE DEVELOPMENT OF AMERICAN LOCOMOTIVES.—II.

WHILE the engine illustrated as No. 6 in the last issue bore a striking resemblance to present designs, owing to changes made after the date of its original construction, the "Tiger," shown as No. 7, is perhaps a better representation of one of the stages of the development that marked the differences in the engines built in the forties and sixties.

This engine represents a transition period between the typical old and new constructions. The old construction is embodied in the outside frames and small boiler, and the new by the outside cylinders and link motion for operating the valves. The engine was, moreover, very profusely ornamented. This appeared in the decorations of the cab and gaudy colors with which the running gear was painted. The mouldings of the castings also serve as forerunners of the later style of ornamentation when form had taken the place of color. The working parts of these engines were still light; the side and connecting rods were round and finished from end to end. It will be noticed that small sheets only were still available, as evidenced by the many-riveted seams of the smokestack. Brass was profusely used for ornamentation and was employed for the lagging bands, hand rails and acorns. The steam chest was unjacketed and the cylinders were lubricated from the front end. The use of the outside frames was discontinued very soon after the date of the construction of this engine. In this engine the cab has assumed the definite and final form which it has retained in the most recent output. The use of the two domes that appear in this illustration was a very common practice but was soon discontinued as it was found that the advantages in extra storage capacity for steam did not compensate for the additional expense involved in the construction.

In No. 8, which illustrates an eight-wheeled express passenger engine built in 1863, we find that the form of the American type of locomotive has been fully developed. The equalizing levers, previously introduced, permit the same weight to be imposed on each of the driving wheels; the cylinders have dropped down to a horizontal position outside the frames and in the line with the center of the driving wheels, while the bogie four-wheeled truck has assumed its definite typical form. The boiler, however, is still small with its firebox located between the axles of the driving wheels, and, in this case, it is designed for the burning of wood. The large flaring stack served as a receptacle for the cinders that did not pass through the wire netting at the top. The pump used for feeding the boiler had been perfected and was operated by a plunger attached to the crosshead. The latter ran in four-bar guides that were stayed at the back end by a brace running up to the shell of the boiler. The valves were operated by the link motion. The cylinders were oiled by a lubricator in the cab.

Among the details of construction it will be noticed that while the slide-rod is round the connecting rod has been given a rectangular section, thus securing a better distribution of the metal to resist the vertical stresses. The double dome has given way to the extended wagon-top with a single large dome placed thereon. Engines of this type usually had cylinders of 15 or 16 inches in diameter with a piston stroke of 22 or 24 inches.

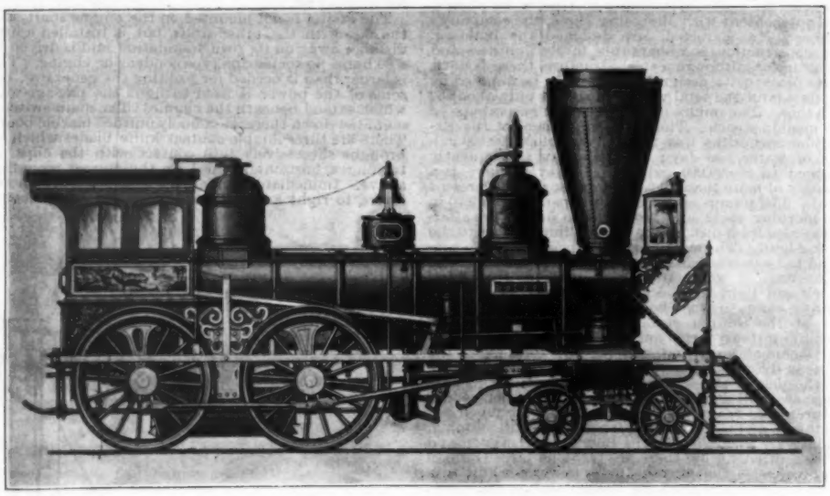
During the civil war comparatively little progress was made in the development of locomotive construction. Hence, we find that there are few differences between the four-wheeled engine of 1867, as illustrated by No. 9, and that of 1863. The principal points lay in the modification of the contour lines with a better display of taste in the ornamental mouldings that were used. The dome was moved back to a position immediately in front of the cab and the weights were increased. The guide brace, bolted to the frames, has assumed the definite form which it has since retained, the lifting shaft has been placed above the frames, and the rocker box has been moved to the rear of the back end of the guides and made to serve as the point of attachment of the guide brace. The five years elapsing between Nos. 6 and 7 show merely a development of details without the introduction of any radical ideas.

The drawings now skip over an interval of ten years during which period there was a marked change in locomotive construction. During this time the use of wood as a fuel was rapidly disappearing and the introduction of coal-burning locomotives was making rapid progress. Consequently, in No. 10 we find that we have reached an early stage in the final development of the modern express passenger locomotive. The difference between it and those which follow it lies principally in size. The straight open stack with deflectors and netting in the smoke box had been developed and brought to a condition of satisfactory efficiency. The use of I sections for the rods had been adapted and the modern engine, with the exception of size, had been worked out.

The air brake had been introduced and an application of brake shoes been made to the driving wheels. The use of metal for the cab was coming to the front and steel was being rapidly introduced as the material for boiler construction.

While large driving wheels had been extensively used in English practice very little had been done in the United States beyond a few abortive experiments. The American train was constantly increasing in weight and no attempts were made to haul these great loads at high speeds. It was realized that the upper limits of boiler capacity with the small fireboxes had about been reached, so that the dimensions of the working parts of the engine were kept within reasonable bounds. Such an engine, therefore, as that represented in No. 10 would have driving wheels about 62 inches in diameter.

The boiler carried a steam pressure of 125 pounds per square inch and was 4 feet in diameter, contained 135 tubes and had, in all, 1,050 square feet of heating surface. The grate area was 17 square feet and this was considered sufficient, under favorable conditions, to supply steam to cylinders 17 inches in diameter, having a piston stroke of 24 inches. But this was the upper limit of cylinder dimensions that it was found possible to use with this amount of heating surface.

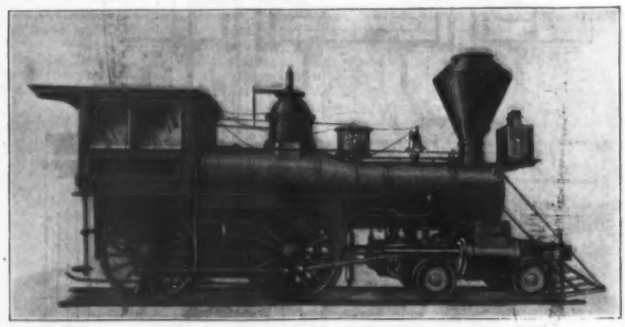


No. 7.—THE "TIGER," BUILT IN 1856 FOR THE PENNSYLVANIA RAILROAD BY MATHEW W. BALDWIN.

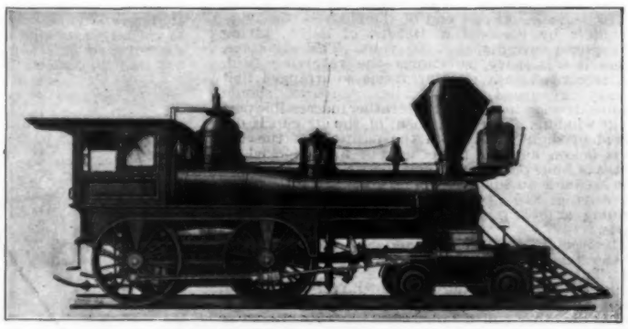
The weight of such an engine in working order was about 79,000 pounds, of which 51,000 was upon driving wheels and thus available for traction.

This engine may, therefore, be considered as being about the most powerful that it was possible to construct along the lines so long followed of placing the firebox between the frames and limiting it, in length, by the distance between the driving axles.

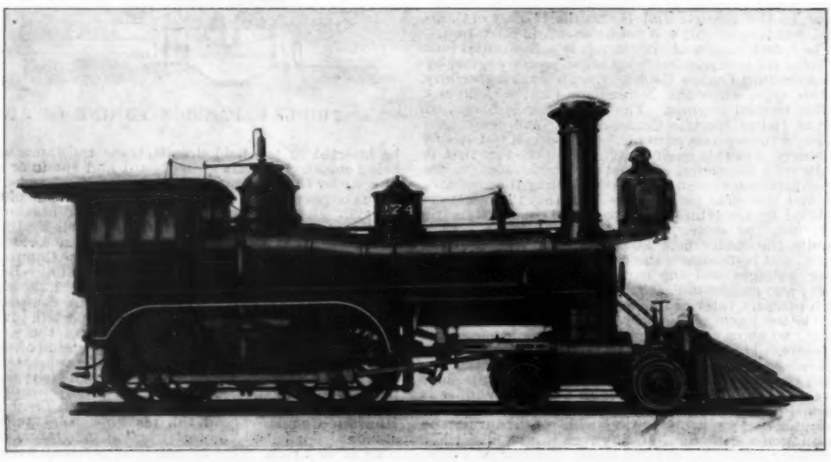
Four years later, or in 1881, the problem of obtaining a more powerful express locomotive was solved by the construction of the engine shown as No. 11. This engine, originally known as the Class K locomotive of the Pennsylvania Railroad, represents the most radical departure in locomotive construction that had been made since the introduction of the link motion. Before this time the fireboxes were placed between the frames and between the front and rear driving wheel axles. This kept the center of the boiler low, and not more than 5 or 6 feet above the rails. The grate area was, therefore, necessarily very limited. As a result the heating surface obtainable did not exceed 1,200 to



No. 8.—EIGHT-WHEELED EXPRESS PASSENGER LOCOMOTIVE, 1863.

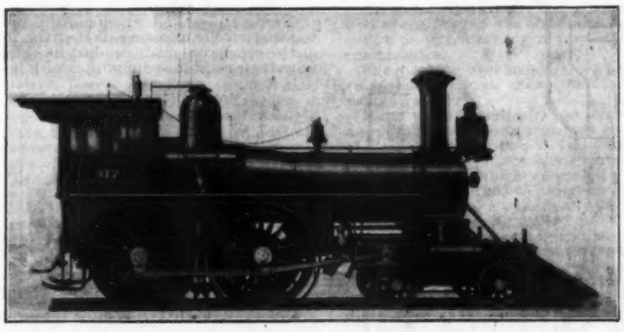


No. 9.—EIGHT-WHEELED EXPRESS PASSENGER LOCOMOTIVE, 1867.



No. 10.—EIGHT-WHEELED EXPRESS PASSENGER LOCOMOTIVE, 1877.

1,300 square feet. In this engine the boiler was raised so that the center of the shell was 7½ feet above the rails, and the firebox was placed upon the top of the frames and extended over the rear driving axle to the back end of the cab. This gave a length of firebox of 10 feet on the inside. The firing was done from the



No. 11.—CLASS K, EXPRESS PASSENGER LOCOMOTIVE OF THE PENNSYLVANIA RAILROAD, 1881.

tender. Owing to the weight and resistance of the links and the valve motion, these engines were provided with a steam reversing gear placed on the side of the boiler immediately in front of the cab. The location of the firebox on top of the frames and extending out to fill the space between the wheels necessitated a remodeling of the method of spring suspension. The driving springs and equalizers were, therefore, placed beneath the frames, the former being suspended by a pivoted connection from the boxes. This innovation in the location of the firebox marked a new era in American locomotive construction and opened the way for the high centers of gravity and large boilers used in modern locomotives. Another peculiarity that marked this locomotive and which has been followed by all subsequent designers in the United States, is the elimination of all ornamentation in the shape of mouldings and filigree work that was characteristic of the outlines of previous designs. The casting of the dome, sand box and cylinders, as well as other projecting parts, were smoothly rounded off and left perfectly plain and simple. While the engine is not large when compared with those built since that time, it was, at the period of its construction, the largest and heaviest passenger locomotive in use in the United States.

The dimensions were, however, not greatly in excess of those given for No. 10 when taken absolutely, but were quite sufficient to add very materially to the proportional power of the engine. The diameter of the shell of the boiler was increased to 49¼ inches for the internal diameter of the smallest ring, and 201 tubes of 1⅞ inches outside diameter were used. The great change, however, was made in the firebox, which was increased to a length that lacked only ⅛ inch of being 10 feet, with a width, inside, of 3 feet 5¾ inches. This gave a total heating surface of 1,205 square feet with 34·8 square feet of grate area, in which there is a notable increase over what had gone before. With the increase of dimensions the steam pressure was also raised to 140 pounds per square inch.

This increase of heating surface and boiler capacity made it possible to increase the size of the cylinders. They were, accordingly, raised to a diameter of 18 inches, though the standard stroke of 24 inches was retained. The increment of power thus gained enabled the designers to take a bold step ahead in fixing the diameter of the driving wheels, which was made 78 inches, and spaced 7 feet 9 inches from center to center.

The weight of the engine in working order was 92,700 pounds, of which 65,300 pounds were upon the driving wheels.

Naturally the advent of such an engine attracted a great deal of attention, and, before its trial trip, many fears were expressed as to its safety. It *looked* too top-heavy to remain upon the rails, despite the fact that careful calculations showed it to be perfectly stable. Still, so prevalent was the opinion that it would upset at high speeds that, on the first run down the mountain from Altoona, the speed was limited to forty miles an hour, but the machine ran so smoothly and evinced such a total lack of an inclination to upset, that, on the return, a speed of sixty miles an hour was attained and maintained over the sharpest of the curves. This engine having demonstrated the practicability of running a locomotive with a comparatively high center of gravity at high speeds, other designers immediately imitated it, with the result that the principal feature of its design, the high boiler and firebox on top of the frame, have become fixed as one of the standards of later American practice.

(To be continued.)

A FOLDING FOOT-BRIDGE AND FOLDING PUSH-CART.

WE reproduce herewith, from La Nature, a folding foot-bridge, as well as a folding push-cart constructed by M. D. Doyen, of Brussels.

The bridge, which is designed for crossing a small watercourse, or any other obstacle, takes up but little space when folded, and is, hence, easily transportable. It can be opened out and put in place in a few minutes. Its frame is formed of wooden lazy-tongs strengthened with iron. Its floor and handrails fold up and unfold like the sides of the structure.

The bridge, with a few modifications made according to requirements, is adapted for numerous applications. The simplest style permits of crossing a stream from 3 to 18 feet in width. This type can be separated into three parts and be carried upon the back of a man. It is used in the Belgian army by sharpshooters, and by explorers and excursionists.

A second style, which is represented in the accompanying figure, permits of making a crossing of from 3 to 33 feet. It is mounted upon wheels and may be drawn by man, animals, or an automobile. It is used in the army by flying columns for moving soldiers to another bank, for supplying provisions, etc. This type can be arranged in such a way as to permit of removing it after the stream has been crossed, so as to leave no trace of the passage.

Another model, which serves for making crossings of from 3 to 60 feet, is mounted upon four wheels and can be hauled by animals or by a traction-engine. It is employed in the army for the rapid crossing of streams.

Finally, there is another type designed to permit persons to pass from the window of one house to that of another across the street in case of a fire. As the folding foot-bridge occupies but little space, it may be used also for passing from the deck of a boat to a wharf.

The folding push-cart above mentioned is represented in Fig. 2 both closed and open. Upon the axle of the

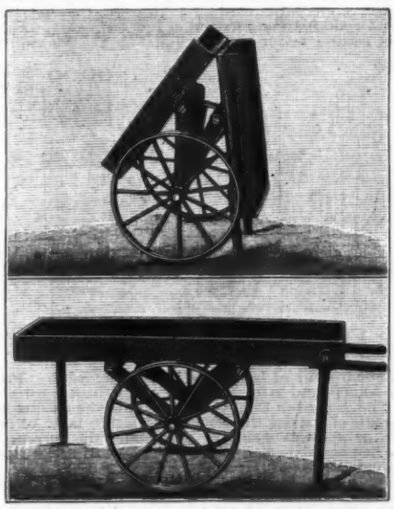


FIG. 2.—FOLDING PUSH-CART.

two wheels are two movable supports connected with the two halves of the cart. The latter, which are hinged, are fixed at will by a bolt. This sort of a cart is usually employed by street-venders, who often have to pay rent for the storage of their carts at some distance from their dwelling place. As the folding cart occupies but little space, it can easily be stored at home. Three or four of such vehicles, when folded, can be placed in a space that would be able to accommodate only one ordinary cart.

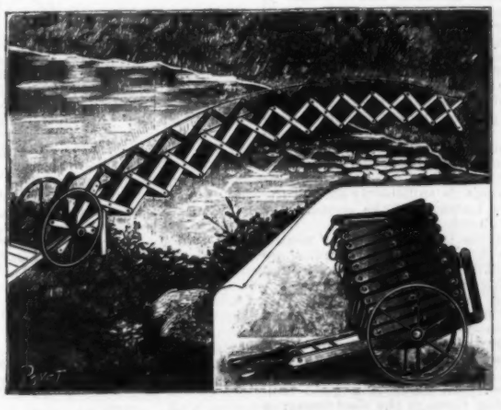


FIG. 1.—FOLDING PORTABLE BRIDGE.

LINE LEAKAGE AND CHARGING CURRENTS.

By Prof. W. E. GOLDSBOROUGH.

TO-DAY it is a confirmed fact that power can be electrically transmitted at 40,000 volts with certainty of successful operation. At this pressure all difficulties of insulation, line leakage and lightning protection have been overcome even in climates offering the most adverse conditions. The matter of line insulation, indeed, has so far advanced that no trouble need be apprehended from this source, even when laying out plans for the use of exceptionally high voltage. A few years ago there was not an insulator on the market that would stand a test pressure of 25,000 volts, whereas now factories are turning out materials capable of withstanding a continuous test at a voltage many times this value. As the demands of practice become the more exacting it can reasonably be expected that the art of insulator construction will keep pace with such demands—judging the future by the past.

As the pressure of a transmission line is increased, the line insulation is less and less affected by weather conditions. If insulators under favorable laboratory conditions withstand the high voltage test, they will probably give ample satisfaction when installed on the line, as the energy dissipated by leakage over a damp insulator quickly dries it and a further accumulation of moisture is curtailed by the electrostatic repulsion of the vapor particles.* The full pressure should never be suddenly thrown on a transmission line that has been out of use; instead the circuit should be closed when the generators are only partly excited, and the voltage gradually built up. By following this plan, the line is dried out before the maximum voltage is reached and the danger of a breakdown is greatly reduced.

A formidable obstacle to very high voltage transmission presents itself in the form of leakage of energy between adjacent lines after a pressure of 60,000 volts has been reached. This effect has been studied chiefly in latitudes in which the humidity is relatively high, where but a poor indication is given of that which is to be expected under more favorable conditions. That leakage would in any wise prove a hindrance in dry atmospheres is much to be doubted, as the dielectric strength of air improves greatly when it is freed from foreign matter and in a pure state to sustain electrostatic stress. In latitudes where it is necessary constantly to combat heavy rain and snow storms, leakage has not proven serious at 40,000 volts, and the experiments so far reported point to the fact that in almost any climate energy can be successfully transmitted over lines at 100,000 volts pressure with a leakage loss not in excess of 250 watts per mile when wires are strung on parallel pole lines upwards of twenty feet apart. Under these conditions the line would have an impedance factor of something like one and one-third. The transmission of 10,000 kilowatts 100 miles under these conditions at 100,000 volts would entail a leakage loss of only a fraction of one per cent. However, on the other hand, if only 1,000 kilowatts were transmitted, the leakage would remain about the same in amount and be from two to three per cent. of the power transmitted.

The laws governing the loss of power by leakage currents between wires through the air have not been sufficiently studied to enable the formulation of any definite rule further than that the leakage from wires of small cross-sections is greater than the leakage from wires of large cross-sections, other things being equal, and that if wires are installed having diameters not less than 0·15 inch or greater than 0·75 inch, the leakage current will lie between 100 and 300 watts per mile when the relation between the voltage impressed on the system and the distance between wires is made to conform to the formula:

$$V = 40 + \frac{D}{4}$$

in which V is expressed in kilovolts and D is the distance between the wires expressed in inches.

In considering the transmission of power at high voltages there is another item that must not be lost sight of in determining the most economical voltage to employ, namely, the charging current that is present in every transmission system but which is usually too small to be recognized. If, for instance, it is wished to transmit 1,000 kilowatts 25 miles at 10,000 volts, the charging current will amount to about half an ampere if a low frequency current is employed, while the power current will be upward of 100 amperes. In this case the charging current has an insignificant value. If, however, the same transmission is attempted at 100,000

* See "Moisture on High Tension Insulators," by Lieut. W. Stuart Smith, in The Journal of Electricity, Power and Gas for September, 1898; Vol. VI., page 87.

volts, the charging current will rise to five amperes while the power current will fall to ten amperes. Here a different state of affairs is presented. The charging current is not a wattless component of the line, in the ordinary sense of the term, but is in advance of the impressed electromotive force by less than 45°; it, however, constantly decreases in amount as points on the line more and more remote from the generating station are attained. It, of course, dissipates power in heating the line, although not the amount its initial value would indicate, but more particularly it calls for a current capacity in the generating station in excess of what would be required by the power current alone.

To further illustrate this point: Consider a transmission line conveying 1,000 kilowatts of energy at a low frequency and at 100,000 volts to a distance of 100 miles. The power current will still be ten amperes, as in the preceding instance, but the charging current, which will be upward of 20 amperes, will necessitate the installation of machinery rather to the end of taking care of the charging current than of taking care of the power current. But again, 10,000 kilowatts transmitted under like conditions would put the charging and power currents in the ratio of 20 to 100 and present a much more economical relationship.—The Journal of Electricity, Power and Gas.

RECENT DEVELOPMENTS IN NERNST LAMPS.

ALTHOUGH the fundamental mechanism of the Nernst lamp has now been patented for some years, and largely capitalized companies have been formed for the purpose of exploiting these patents both in this country and abroad, yet the only instance of its commercial employment so far has been in Göttingen, and that quite recently. Engineers, however, have not been idle, and in the meantime we gather that much time and energy, and also money, have been expended in developing and improving this lamp. Judging from the Patent Office files, these attempts have not been directed at merely evading Nernst's fundamental patent, but rather at devising improvements in the lamp itself which would render it more convenient to use.

The first patent to which we desire to draw attention (No. 6,034, 1899) was taken out on behalf of the Allgemeine Electricitäts-Gesellschaft, and describes a form of lamp which can be fitted to an ordinary Edison or Swan lamp holder. The special features of this type of lamp are clearly indicated in Figs. 1, 2, 3. The

FIG. 1.

FIG. 3.

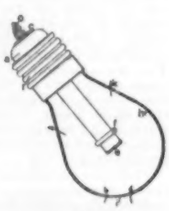


FIG. 4.

illuminating body, *e* (Fig. 3), is connected, in a manner which will be described later on, to two metal wires fastened to the pointed metal pieces, *g g*. These are forced into the slotted metal tubes, *d d* (Fig. 2) and the complete holder is then screwed or otherwise fastened onto the globe, which also contains openings for the introduction of the light which heats the pencil. This lamp very readily admits of the interchanging of the pencils and cleaning the globe. Fig. 4 illustrates a similar lamp for obliquely-placed lamp holders, *u* being a small spring attached to the contact piece, *c*, and insuring constant connection with the center of it. Slight modifications of the above holder are described for adaptation to a Swan lamp. The simple form of the type of lamp just described has the advantage of cheapness, but on the other hand, the necessity for holding a light to it for some little time renders its employment somewhat inconvenient, and must react against its exclusive or even extensive use. This difficulty has been ingeniously met and, we suppose, overcome in the lamps described in patents Nos. 6 025, 6,026 (1899), also taken out by the Allgemeine Company. The principle made use of is in every case to pass the current simultaneously through an auxiliary heating coil in close proximity to the illuminating pencil and the parallel circuit containing the pencil itself. At first, when the pencil is cold and its resistance is extremely high, nearly all the current will pass through the auxiliary coil. This becomes heated, and in turn raises the temperature of the pencil, which rapidly increases in conducting power, taking an increasing portion of the current. The auxiliary circuit is completed through a steel contact key situated near to the iron core of an electromagnet placed in series with the illuminating circuit; and when finally the current passing through the circuit is sufficiently strong, the core will attract the steel hammer of the contact key and break the auxiliary circuit.

Figs. 5 and 6 illustrate the lamp and holder respectively of a lamp of this kind. The two circuits are here plainly discernible. The first passes from *r* through the iron piece, *b*, making contact with the screw, *c*, and through *e* and *h* to the auxiliary heater, *p*, and back through the parts marked *n*, *i*, *f*, *u* to the other leading wire, *s*. The second circuit starts also from *r* and passes round the coil, *t*, of the electromagnet, and thence through *l* to the illuminating pencil, *o*, and back as before. When the temperature of the pencil has been raised sufficiently to make it a good conductor, the current passing through the electromagnet will cause the core to attract the iron piece, *b*, and break the auxiliary circuit. Fig. 7 illustrates another lamp of the same kind. In this case the auxiliary heating circuit may be traced from *g* through the metal bobbin of the electromagnet, which at its lower extremity rests on the contact tube, *d*, and from this through the heating coil, *o*, and back along the dotted line to *n*. The pencil, *p*, in this case inside the heating coil, is electrically connected to the coil of the electromagnet, *k*, to which *g* is also connected. When this circuit takes a sufficient amount of current the iron core, *i* will be drawn up into the coil and the auxiliary circuit will thus be broken. A slight modification of the construction of this lamp readily adapts it for the case of bayonet contacts instead of the sliding contacts illustrated in the figure.

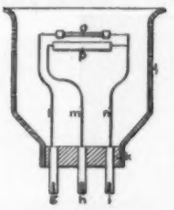


FIG. 5.

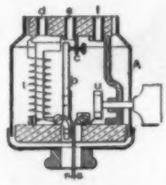


FIG. 6.

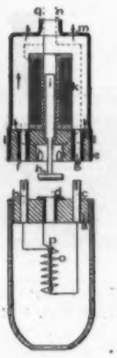


FIG. 7.

The same object is attained in a slightly different manner in the case of a lamp patented by the British Thomson-Houston Company (patent No. 5,941, 1899) and illustrated in Figs. 8 and 9. In this case the pencil is surrounded by a heating coil, *c*, of high resistance, and an arrangement is provided whereby the current in this circuit is automatically broken when the pencil, *d*, takes a sufficient amount of current. Porcelain, clay, or magnesia are some of the substances mentioned in the specification for the illuminating pencils. It is partially claimed for this type of lamp that it is specially suited for high-voltage circuits and also for alternating currents of low frequency. Fig. 9 is a section taken through 3-3 (Fig. 8). An entirely

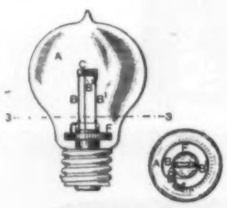


FIG. 8.

FIG. 9.

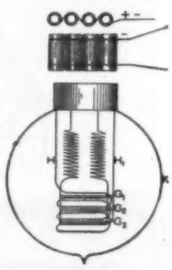


FIG. 10.

different kind of lamp has been designed by Prof. Fessenden, and is described in the February number of The American Electrician. In this the mechanism permits of coating the pencil with a thin layer of carbon or graphite sufficient to conduct the current in the first instance, and finally to be burned away when the pencil is working properly. This coating of graphite must be re-applied on every occasion on which the lamp is to be lighted.

The lamp shown in Fig. 10 is specially designed to hold a reserve of several pencils, each of which comes automatically into use when the lower one has burned out. The method of arranging these pencils is shown in the side view.

A lamp of somewhat different type was patented by the British Thomson-Houston Company (No. 13,404, 1899) and is represented in Fig. 11. Here the auxiliary

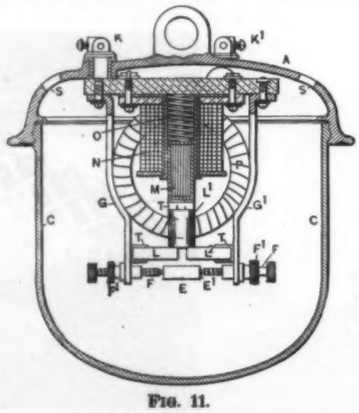


FIG. 11.

heating is performed by striking an arc in close proximity to the pencil, the flame of which heats it. When this conducts sufficiently well, a solenoid in series with it draws the carbon pencil up and the auxiliary circuit is thus broken.

Mr. Hirst, of the General Electric Company has patented (No. 24,264, 1898) also a switching device for use with Nernst lamps of the independent heating circuit type. This is illustrated in Fig. 12, which is self-explanatory. The first figure represents both circuits open; the second, the heating circuit open and the filament circuit closed; the third shows both circuits closed. In use, the heating circuit switch is "held" for an instant, during which time the filament will have become sufficiently heated to conduct, and is then allowed to fly back by means of the spring arrangement shown.

The great difficulty in connection with all types of Nernst lamps, and which must in the first instance be satisfactorily overcome, is that the materials of which the pencils are made conduct like electrolytes, in so far as their resistance diminishes with increasing tempera-

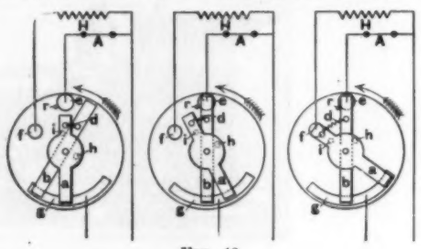


FIG. 12.

ture. There exists, therefore, considerable danger that the illuminating pencil will be burned out. Much ingenuity has been expended in discovering a material which would properly compensate for this effect by a corresponding increase in its resistance under the same circumstances. In the Allgemeine patent specification (No. 6,027, 1899) no materials are specifically referred to as being employed, but it is intended to apply broadly to all materials having a high temperature coefficient. This compensating resistance is to be placed near to the pencil, and to be subjected to a slight preliminary heating in order to bring it more nearly in correspondence to its resistance when the final current passes through it.

Another important difficulty lies in the method of connecting the non-conducting pencil to the metal wires connecting it to the external circuit. Patents have been taken out by the Allgemeine Company for the following soldering mixtures, which are said to be suited for this purpose:

	Thorium Per cent.	Zirconium Per cent.	Yttrium Per cent.	Cerium Per cent.
1.	93·7	3	3	0·3
2.	80·0	..	20	...
3.	95·0	..	5	...
4.	70·0	10	20	...
5.	70·0	..	30	...
6.	80·0	..	19·5	0·5

In addition to these, Messrs. Siemens & Halske have patented a method (18,489, 1899), in which by the repeated heating of the pencil to incandescence, and dipping into certain powders or pastes of the following metalloids—boron, silicon, and their oxygen-free compounds—the ends become soft and admit of the conducting wire being pushed into it. The metals manganese, molybdenum, chromium, titanium, nickel, the platinum group of metals, and the oxygen-freed compounds of these metals, such as the sulphides, phosphides, nitrides, and carbides, are referred to as being suited for the same purpose.—The Electrician.

TELEGRAPH AND TELEPHONE WORK IN THE PHILIPPINES.

AMERICAN engineers and electricians will be interested in the application of electricity to military purposes which has been carried out on a scale unprecedented in warfare by the United States Signal Corps. This work, as well as that done in Cuba and Puerto Rico, has attracted the attention of electricians in all civilized countries. Indeed, it is within the past month, as noted in these pages, that The Telegraph Chronicle, the organ of the British telegraphers, made a strong appeal to its own men, and described in glowing terms the gallantry of American telegraphers during the Spanish-American war. The superintendent of the British Telegraphs says: "It is our men's ambition to do as good work as the American telegraphers did for their country; they have given us our ideal, and we will try and work up to it." This is an unprecedented compliment to the courage, ability and efficiency of the American Signal Corps.

General A. W. Greely, in his annual report, points out that the operations of the Signal Corps have been coincident with every military operation in the Philippines. Under Major Richard E. Thompson, backed by the high moral standing and professional knowledge of the enlisted operators, they repaired the English cable in Manila Bay and assisted in restoring the Eastern Extension cable around the Viscayan Islands. A Signal Corps cable laid from Manila to Cavite furnished for months the only means of communication. The local telegraph and telephone system included not only corps, brigade and division headquarters, but was extended to every regiment in the command. When the insurrection broke out, every telegraph line to the northward was cut in Manila by the insurgents at 10 o'clock at night, but by daybreak every line was repaired and in operation. No expedition entered the field without a Signal Corps detachment, and no commanding officer of such an expedition ever pitched his tent without a telegraph or telephone office at his side, a single exception being Lawton's flying column, when that indefatigable soldier and resourceful officer found even his wonderful energy almost unequal to a wild tropical country impassable by typhoon rains.

During the civil war it was occasionally asked if any one had ever seen a dead signalman; but the men of the Signal Corps in the Philippines have operated under different conditions, establishing and operating

offices on the firing line. The signalmen have been present and under fire in no less than 61 skirmishes or engagements, and the percentage of dead, wounded and prisoners is as great in the Signal Corps as in any other organization in the Philippines.

It was admitted that the record of 260,000 military messages transmitted in the ten months ending June 30, 1899, on the island of Luzon broke the record for military telegraphy; but it has since appeared, however, that telegraphic work had only commenced, and from 700 messages a day the average has rapidly risen since July last, and in September aggregated for the month 74,000; and in October the number rose to 3,000 daily, and remained nearly stationary at 4,000 daily during November and December. An extension of field operations during January has, however, brought on a great increase, and during the month of January the average has exceeded 5,000 messages each day.

The field outfit of the Signal Corps is a novelty in telegraphy. The signalman carries a box of about nine cubic inches, the invention of Colonel James Allen and other officers of the Signal Corps. It affords communication either by telegraph or telephone through the instrumentality of a so-called "buzzer." This "buzzer" is a vibrator operated by a high tension current generated from a dry battery and an induction coil carried in the box. The wire used is No. 22 copper carried on a portable reel when used in connection with outposts. A seven-ply wire of two gages consisting of six steel wires is wound around a copper wire of the same diameter. This makes an extremely flexible yet strong wire of great conductivity. Large quantities of the seven-ply wire insulated by almost pure Para rubber are used in active military operations, while in commercial operations naked wire is used, which is placed on lances and secured by rubber insulators. When military operations are rapid, insulated wire is used by one detachment, who keep up with the advancing columns, and this insulated wire is replaced by a second detachment following by naked wire.

The "buzzer" has been a most valuable adjunct for communication. It operates through connecting wires miles in extent whether through swamp or lying on the ground. On one occasion it made available for a week a copper circuit 30 miles long laid upon the ground without any insulation whatever. Similarly it has worked the Signal Corps' cables at times when mechanical injuries to the cable had caused serious leaks.

The adaptability of the Signal Corps man has been shown on many occasions where unusual methods of communication were speedily improvised. A striking case is instanced of an occasion at the capture of La Loma, where communication between the Pennsylvanians and South Dakotas and the brigade commander was most essential for co-operative movement. It chanced that there was a wire fence a mile or more in length, one wire of which was connected by Captain Edgar Russel at both ends with the signal wire, and by means of the "buzzer" the Signal Corps operators worked over the entire line, including the fence line.

The Signal Corps office at Manila is first-class in all its equipment. It has a hundred-wire switchboard, a dynamo and storage battery system for furnishing line current, and other up-to-date apparatus. All messages are taken on the typewriter. In this office center daily all reports from every military command on the island of Luzon.

Despite the vast volume of business done, everything goes on systematically, regularly and promptly as if in the United States. Owing to the lack of mails and post-roads, business of all character is necessarily carried on by wire, whether it pertains to food, forage, animals, orders or other business. The volume of work done is so great that often only the more urgent military messages can be handled. There are over 100 Signal Corps telegraph offices in operation on the island of Luzon alone. The telegraph system is supplemented by telephones which replace the key and sounder on all short lines. Nearly 200 long distance Bell telephones are operated by the Signal Corps in Manila and its immediate vicinity, this being the only way in which public business can be promptly done.—Electrical World and Engineer.

ON KRYPTON.*

By Profs. A. LADENBURG and C. KRUEGEL, of Breslau.

AFTER much work with liquid air, and many researches on the measurement of low temperatures and the separation of bodies by this means, we consider we are in a position to solve a few questions which have been raised by the splendid researches and discoveries of Ramsay and his co-workers. It seemed to us possible to obtain krypton, of which only little was known at the time we began these labors, in a state of greater purity, and to settle somewhat more accurately its properties, specially also to prove if its atomic weight really amounts, as Ramsay assumes, to 80—82.

The beginning of this work goes back more than a year, as the first large quantity of liquid air which we could obtain (in March of the past year) was lost in transport, and we were only placed in the position to replace this last autumn. In the meantime, Ramsay has also worked up larger quantities of liquid air for krypton, as we are informed by the report which appeared in the Chemiker Zeitung of the Munich Congress of Physicists. Still there has appeared no authentic publication on krypton (at least known to us) since the first publication in the Comptes Rendus (see also Zeitschrift für physikalische Chemie, xxvi., 362) and the address published by Ramsay in the German Chemical Society (Deutsche Chemische Gesellschaft, December, 1898), so that we saw no ground for interrupting the work once begun.

After we had learned that the factory Rhenania, near Aachen, had erected a Linde's air-liquefying machine capable of furnishing 50 liters of liquid air per hour, we entered into negotiations with them, and we were permitted to utilize for our purpose the residue of evaporation from 1,000 liters of liquid air. Unfortunately there occurred many interruptions in the management of the machinery, so that it was three weeks before a quantity of 850 liters liquid air was gained, of which one of us (K.) brought here as much as 3 liters of the evaporated residue in two Dewar bulbs, where we collected the gas as it evaporated in large gasometers. We obtained 2,300 liters of gas, which were freed from oxygen by passing over red-hot copper. From the remaining 120 liters the nitrogen was separated by essentially the methods mentioned by Lord Rayleigh and Ramsay for the isolation of argon. The last portions of the nitrogen were always oxidized by sparking with surplus oxygen over soda-lye, and the remaining oxygen was absorbed with pyrogallol and soda. In this way a nearly complete separation of the oxygen was obtained, as when treated with yellow phosphorus only a very slight absorption was recognizable.

For sparking over soda-lye, we have had made glass vessels of the form shown in Fig. 1, which have answered very well.

From these vessels the gas, after being dried with anhydrous phosphoric acid, was collected into several of Ramsay's gasometers.* In such operations it is self-evident that all intermediate parts must be pumped quite airless, for which we used a Stuhl's mercury air-pump, which worked to our great satisfaction.

In this way there were finally obtained 3·5 liters gas, which then were condensed in liquid air. The condensing vessel which contained wires fused in, and the junction of the thermo-element, serving as a thermometer, had the annexed form (see Fig. 2), and was pumped completely air empty before the gas was let in. The gas condensed itself very easy and complete under somewhat raised pressure (which is obtained by the raising of the mercury reservoir which is connected with the gasometer) to a transparent colorless fluid, in which floated small numbers of colorless crystals †

Now the liquefied gas was raised to boiling point by raising the condensing vessel out of the liquid air, and was fractionated into various gasometers, according to the boiling temperatures.

The temperature rose quickly from —189° to —181·2°; there it became tolerably constant, and about 2·5 liters of gas were here collected in bottles 2, 3, and 4, while bottle 1 contained that boiling between —189° and —181°. Then the temperature rose quickly to —153°, where the last portions of fluid evaporated. This part was collected in bottle 5. Finally, there remained a crystalline residue, which melted at about —147°,‡ and then quickly evaporated, and was collected in bottle 6.

The gases from bottles 2, 5, and 6 were now examined with regard to their density, and also as to their spectrum characters.

Gas from bottle 2 (boiling point —181·2°). This

Fig. 1.

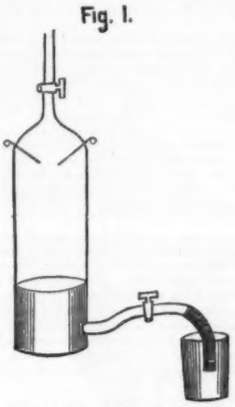


Fig. 2.

SODA-LYE AND CONDENSING VESSELS.

showed a very complete argon spectrum; in addition there was plainly visible the green krypton line, but not the yellow. The density of the gas was next found to be 38·6. But after the gas was mixed again with O, and sparked over soda-lye, then freed from O and dried, it showed a density of 40·34.

Gas out of bottle 5 (boiling point —170° to 153°). Here also there was a beautiful argon spectrum, but on it was seen a very distinct krypton spectrum, in which the line D_3 and the green line were brilliant. The determination of its density gave 42·21 (O = 32), from which it follows that we have to deal with a mixture of argon and krypton, in which the first forms the principal part.

The examination of the gas out of bottle 6 furnished unexpected results; here we saw a strong krypton spectrum in which the lines D_3, 586·9 $\mu\mu$, and the green line 558·1 $\mu\mu$ were brilliant, like hydrogen lines. Besides, there were several very faint lines; which we were inclined to consider as argon lines. The question whether argon was really present appeared to us of importance, and its affirmation was so much more doubtful, as the characteristic argon line, according to our estimation, the orange line 603·3 $\mu\mu$, as also the most refrangible violet lines, were totally absent. We have, therefore, submitted our krypton spectrum to an accurate examination, and have measured a large number of lines, using a spectrometer which admitted of a reading to half a minute. We add here in column I. the red argon spectrum measured by Crookes; in column II., the argon spectrum measured by us; in column III., our krypton spectrum; and, finally, in column IV., the krypton spectrum measured by Ramsay and Travers, concerning which we may remark that in the latter are left out the argon lines observed as the same time (compare Zeit. für phys. Chem., xxvi., 363).

It is seen on comparison that ten lines of our krypton spectrum, of which seven are in the red, are identical with argon lines, but that several of the fainter argon lines, together with the whole violet end of the argon spectrum, do not occur in our spectrum. As it appears to us, one must conclude therefrom that either very little argon or only a constituent part of the argon is contained in our krypton.

	Argon. I.	Argon. II.	Krypton. III.	Krypton. IV.
Red.	764·6	764·4		
			761·5	
	750·6	749·0		
	737·7	738·3		
	726·3	726·7		
	—	716·3		
	—	715·3		
	705·64	**708·8**	707·6	
	696·56	**697·3**	697·3	
	684·2	688·9		
	675·4	676·0		
	664·4	669·2		
			645·2	
Orange.	**640·7**	**642·3**		
	637·7	638·3	638·1	
	630·2	631·9	631·0	
	628·1	—		
	621·0	623·2	624·3	
	617·3	617·1	617·8	
	614·3	614·6		
	609·9	610·6		
			608·3	
	605·6	605·7	605·7	
	604·5	—		
	603·8	**603·3**		
			601·45	601·1
			599·2	—
Yellow.	593·5	—		
	592·6	—		
	590·9	590·7		
	588·7			
			586·9	**586·77**
	585·8	—		
	583·4	—		
	580·3	—	—	582·9
	577·1	—		
	574·6	574·8		
Yellow-green.	568·3			
	565·1	565·5	565·9	—
	561·9	561·3		
	556·7	557·6	**558·1**	**556·8**
	555·7	556·8	557·3	556·0
	552·0	—		
	550·1	550·2		
Green.	549·65	—		
	545·6	546·0		
	544·4	—		
	542·1	542·5		
	525·8	525·6		
	522·2	522·0		
	518·58	519·2		
	516·5	**516·5**		
	506·5	—		
	501·2	—		
Green-blue.	496·55	—		
	493·8	—		
			492·0	
	487·9	—	491·3	490·9
			484·0	483·4
	—		482·5	483·0
		481·5		
			480·5	480·7
			478·6	478·6
Blue.	470·12	470·6	470·0	—
			467·5	467·1
	462·95	463·3	462·3	—
	459·45	459·7		
	451·4	—		
	450·95	**451·6**	**450·5**	—
Violet.			446·6	
			445·5	446·1
			437·5	438·7
			436·4	—
	434·5			
	433·35	**433·7**	**432·5**	**431·7**
	430·05	**430·2**		
	427·2	427·5	427·8	—
	426·6	426·8		
	425·95			
	425·15			
	420·10	**420·5**		
	419·8			
	419·15	419·2		
	418·3	418·4		
	416·45			
	415·95	**416·0**		
	415·65			
	404·4			
	394·85			
	390·45			
	383·55			
	377·15			
	363·25			
	362·37			
	362·28			
	360·50			
	356·65			
	356·28			
	355·45			

The density determination of our gas gave the figure 58·81 relative to oxygen 32. The observed data were the following:

Weight of the gas, 0·0391.
Volume of the globe, 16·864 c. c.
Reduced barometric pressure, 739·4 mm.
Temperature, 19° C.

In view of the small quantity of gas and that the accuracy of our balance does not exceed 0·0001 grm., we estimate the error of our determination at 1 per cent.

For the control of this density determination, the result of which very much surprised us, we mixed the gas anew with oxygen, and sparked over soda-lye. Hereby occurred a not inconsiderable volume reduction, so that we believed that our gas still contained nitrogen. But later it came out that our oxygen,

* Communicated by Hrn. van 't Hoff to the Berlin Academy of Sciences.

* See Zeitschrift für physikalische Chemie, xxviii., 247. These are especially suitable for such purposes.

† Argon also condenses easily in liquid air at about 1½ atmospheres. The boiling point at normal pressure (745 mm.) is between —181·2° and —178·6° (compare against this, Olszewski, Zeit. für phys. Chem., xvi., 393). The inconstant boiling point corresponds to the complete nature of argon.

‡ This melting point-determination can only be looked on as a provisional one, as the mass of the body was not sufficient to carry out an exact determination.

which we considered nitrogen free, was not quite pure.

But we must here expressly point out that we now sparked so long that even after some hours no decrease of volume occurred, so that we could be sure that we had no more nitrogen in our gas.

Then it was freed from oxygen with pyrogallol and soda, and collected over mercury, where it was left standing over yellow phosphorus and fresh fused soda for forty hours. After this a new determination of density was carried out. The data were now the following:

Weight of the gas, 0·0394.
Volume of the same, 16·364 c. c.
Temperature, 17·5°.
Barometer reduced, 743 cm.

Therefrom the density comes out (referring to O=32) at 58·67, in remarkable accord with the first found figure, 58·81.

Therefrom it follows with certainty that the krypton contained no more oxygen, and since very little argon was mixed with it, as already inferred from the spectrum examination, one may well consider it as nearly pure. This conclusion is essentially supported by the fact that this gas originated from a crystalline body, which doubtless speaks for its not being a mixture.

Then comes the question, what position does krypton occupy in the periodic scale if we consider the density 58·8 as nearly correct? We believe that we should place the new group of elements in air before group I., so that He = 4 before lithium, Ne = 20 before sodium, A = 39 before potassium, and, finally, Kr = 59 before copper.

Still this is only a hypothesis which requires further testing. Herewith we are busy, as perhaps through the solid condition of krypton there offers a newer and much more simple road for its preparation, which we have already entered upon.

This consists in the working up of the well separated constituents of the liquid air which evidently will contain krypton next to carbon dioxide, when the solubility in liquid air does not suffice to hold in solution all the krypton present.

THE LINGUAL TRACTOR.

EVERY being whose heart no longer beats and who has apparently ceased to exist may, in many cases, provided he has no lesion of his principal organs and is not exhausted by disease or extreme destitution, be brought to life again. As a general thing, people have no idea of the persistence of "latent" life in those who have been asphyxiated, hanged, drowned, or struck by lightning. A man whom it has been impossible to restore to life after ten minutes effort is dead. At least that is what is believed almost everywhere; although it is a serious error that should be dispelled. We have the conviction that, owing to such a prejudice, many a person who might have been resuscitated has been allowed to die.

On the seventh of June, 1898, Bowman Aguel, of the "Huveaune," was on duty, on the point of the Mediterranean coast known as "Anse du Prophète," when he heard cries of distress proceeding from a sixteen year old cabin-boy named Igardeus. The boy was bathing at a distance of about thirty yards from the shore when he disappeared beneath the water. He had committed the imprudence of jumping into the sea immediately after eating. A man named Ricard, the cabin-boy's master, happening to be near by, jumped in to save him, but was just about sinking in turn when the bowman threw himself into the water without taking the time to remove his blouse. Reaching Ricard, he held him until he could pass him over to a second rescuer, who carried him to the shore. He then made another dive in order to find the second victim, and, in a few minutes, was fortunate enough to be able to carry the cabin-boy to land. But Igardeus was inert, since he had remained under water at least ten minutes. All hope of resuscitating him appeared to be lost; but Aguel, recalling the directions given in circular No. 2463, of November 2, 1894, applied to the boy the process of "rhythmic tractions of the tongue" recommended by Dr. Laborde, of the Academy of Medicine. Although the victim continued to give no sign of life, Aguel, without allowing himself to become discouraged by a probable want of success, persisted in his maneuvers and prolonged the operation for three hours. This laudable perseverance was crowned with success. The boy's respiration was re-established, he gradually became able to rise, and was then out of danger.

This is a succinct resumé of a report by M. Vauter, director of the customs region of Marseilles, to the director-general of the Custom House. A simple officer of the administration had been able, after three hours of rhythmic tractions of the tongue, to restore to life a boy who had remained ten minutes under water. After three hours! Up to 1898, no physiologist or physician would have dared to claim that latent life could subsist for hours. And yet three hours is doubtless not the extreme limit; and it might perhaps be possible to meet with success much beyond this length of time. We do not know exactly at the end of how many hours real death takes the place of apparent death; the interval of time may be very variable according to the individual: but life exists, at all events, in the subject whose organs are healthy and have not become affected by disease.

The objective external death of the organism revealed by the suspension of functional manifestations, especially by the suppression of the cardio-respiratory function, is not complete definitive death. While the organism has ceased to live externally, said Dr. Laborde recently to the Academy of Medicine, it still lives internally. That is to say, life continues in a latent manner through the persistence of the functional properties of the organic elements and tissues. The sensitive properties are the first to disappear, then the nervous motor functions, and finally muscular contractility. Complete death requires time.

Upon the whole, the general mechanism may come to a standstill through the cessation of an essential function, such as that of respiration: but, if the organs are not changed, they may be again excited and be made to resume their normal operation. As long as there is latent life, the saving of an asphyxiated or drowned person must not be despaired of. The function most indispensable to awaken—the primordial function—is the respiratory. It is necessary to excite the respiratory reflex, which, fortunately, as Dr. Laborde shows, has an extraordinary persistence of life. It is to this, then, that recourse must be had in order literally to resuscitate persons who might be considered as absolutely dead.

Dr. Laborde has been testing the efficiency of the method for a long time and is able to mention to us numerous cases of return to life.

How long does the respiratory reflex action survive? Dr. Laborde, in operating upon dogs, found that it lasted two and three-quarters hours. He took a vigorous half-bulldog, weighing 35 pounds, and submitted him to the inhalation of chloroform until respiration had entirely ceased. The dog was quickly put into a state of apparent death. After a quarter of an hour's traction of the tongue, the animal came to. The experiment was tried again until complete asphyxiation supervened, and recourse was not had to traction until five minutes afterward. This dog, which was well named "Lazarus" in the laboratory, appeared this time as if it were really dead. One hour and two hours of traction were followed by no result, and Dr. Laborde feared a setback. Leon Jandon, the laboratory boy, who had an affection for the animal, nevertheless continued the tractions with an imperturbable confidence in the method. He saw the tongue become red—a certain sign of reaction and of the return of the first respiratory motions. In fact, after two hours and a half of rhythmic tractions, a respiratory hiccough occurred, and then successive inspirations supervened.

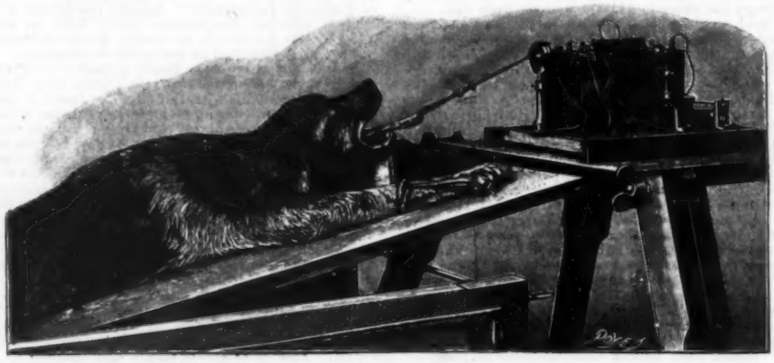


FIG. 1.—THE ELECTRIC LINGUAL TRACTOR IN OPERATION UPON A DOG.

The animal returned to life and began to walk around his friend with an astonished look.

It is therefore possible to assert that the respiratory reflex persists, ready to operate anew, at least three hours after apparent death.

Perhaps the reader will be astonished at our speaking calmly of lingual tractions effected for hours at a time. Bowman Aguel had the perseverance necessary to make a success of them, but it is clear that everybody would not be capable of doing so.

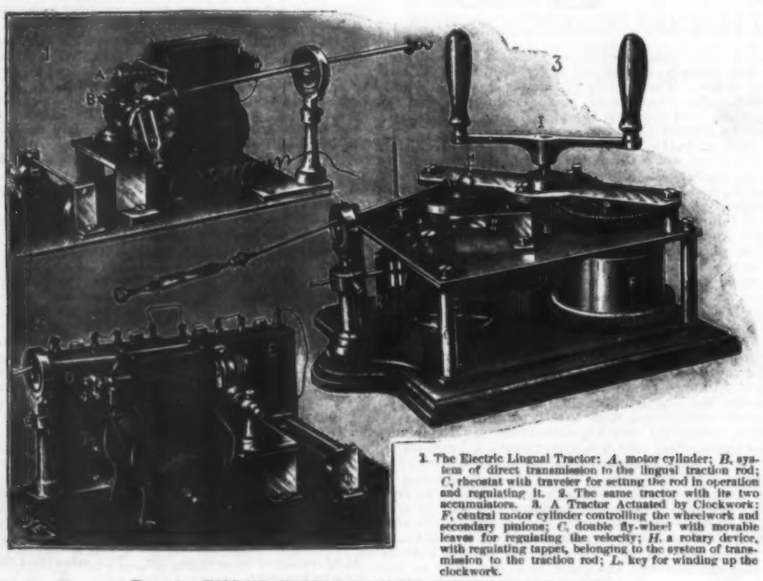
It occurred to Dr. Laborde that it would be a good idea to substitute an automatic apparatus for the hand covered with a cloth, and this having been suggested to M. Mouchel, who had witnessed various experiments in resuscitation made by the doctor, this gentleman in a few days and with his own hands constructed a small apparatus, driven by clockwork, that gave 120 tractions per minute, with all the rhythmic intermittence desirable.

This apparatus, the first one of the kind ever devised, allowed Dr. Laborde to perform laboratory experiments, and served especially for saving the life of the dog Lazarus, above mentioned.

Unfortunately, the spring of the clockwork did not permit the apparatus to operate for more than five minutes. It was necessary to wind up the movement, and that, too, often more than twenty-five times during an experiment. But this difficulty has now been surmounted by the addition to the mechanism of a small electric motor supplied by a few accumulators: so that it is possible to operate for three hours in succession without touching the apparatus (Figs. 1 and 2).

The important method devised by Dr. Laborde for resuscitating subjects in a state of apparent death, constitutes at the same time a method of ascertaining whether a person is really dead. If the respiratory reflex is abolished after more than five or six hours, death is certain.

Hereafter, when a person is carried under the water by a falling tide, or when a fireman becomes asphyxiated by mephitic gases it will be necessary only to have recourse to rhythmic tractions, not for half an hour, but for several hours; and in most cases the unfortunate victims will be resuscitated. So, municipalities, in cases where electric traction apparatus are wanting, should be urged to put automatic ones into the hands of their employés, even if the clockwork movement has to be wound up every quarter of an hour.



1. The Electric Lingual Tractor: *A*, motor cylinder; *B*, system of direct transmission to the lingual traction rod; *C*, rheostat with traveler for setting the rod in operation and regulating it. 2. The same tractor with its two accumulators. 3. A Tractor Actuated by Clockwork: *F*, central motor cylinder controlling the wheelwork and secondary pinions; *G*, double fly-wheel with movable leaves for regulating the velocity; *H*, a rotary device, with regulating tappet, belonging to the system of transmission to the traction rod; *L*, key for winding up the clockwork.

FIG. 2.—THREE VIEWS OF THE LINGUAL TRACTOR.

COMMERCIAL UNIVERSITY FOR HAMBURG.

THE Berlin correspondent of The London Daily Mail, in a dispatch to that paper, says:

"A movement is being started at Hamburg which should prove of exceptional interest to British commercial and shipping circles.

"The very important and wealthy Association of Hamburg Landowners proposes to found a commercial university at Germany's foremost seaport. The institute will have chairs for all scientific and technical branches in any way connected with general commerce.

"Besides purely commercial matters, it will include lectures on history, geography, natural history, modern languages, international and maritime law, tropical diseases, shipbuilding, and harbor constructions.

"As the new institute will enjoy all rights of the German universities and higher technical schools, it is expected that a large number of foreign students will be induced to attend the lectures."

This programme speaks for itself. Germany has led and is still leading the world in commercial education. For many years, its commercial schools have been preparing young men to go out into the world to take up lucrative and important positions. These young men are selling in distant countries products of the empire, ranging from a locomotive to a clothespin. Opportunities for industrial enterprise are immediately reported. The German commercial traveler always speaks the language of the country in which he attempts to sell goods. This gives him an immense advantage over his English or American competitor, who as a rule is lacking in this essential qualification. The efficiency of these commercial travelers is to be attributed directly

to their training. If we had similar colleges of commerce in our country, it is safe to say that our export trade could be largely increased.—Ernest L. Harris, Consular Agent at Eibenstock.

THE TAPIR.

THE tapirs are a family of ungulates, remarkable for their zoological characteristics as well as for their geographic distribution. Four, perhaps even five, species are to be found in the Andes of Ecuador and Colombia at heights of 8,000 to 11,500 feet; two species inhabit the interior of Central America, from southern Mexico to Guatemala; in Asia, a single species is found in Sumatra, Borneo, India, and southwestern China. This wide distribution seems inexplicable; but a study of the relics of prehistoric times will, at least, partially fathom the mystery. In the miocene or middle tertiary, true tapirs lived in western Europe, whence they spread over Asia to the Sunda Isles, which at that time were connected with one another and with the main land. They wandered even to North America, which was then also connected with Asia. Africa, which was still an archipelago and not a continent, they could not reach. At the present time tapirs are found only in the tropical regions of the old and new worlds. In the intermediary European, Asiatic, and North American regions, separated by large expanses of water, they have died out; but their remains are still to be found in the strata of the middle and later tertiary. It is remarkable that certain American species are more closely related to the Indian tapir than to other American species. Few mammals have preserved their original characteristics to such an extent as the tapirs. Paleontologists term the tapir a permanent type. But it is also a cumulative type; for it is an animal that unites in its organism characteristics which have been more fully developed in other mammalian forms, such as swine, proboscidia, and horses. In form, the tapir slightly resembles the pony and the pig. The spinal column curves upwardly from the withers to the croup, then suddenly descends and terminates in a very short tail. The Indian tapir

AN INDIAN TAPIR ATTACKED BY A LEOPARD.

(*Tapicus indicus*), the "maiba" of the Malays, when fully grown, attains a length of six and one-half feet, of which three inches must be reckoned for the tail and two feet for the head and proboscis. This proboscis, rather blunt at the end, is laterally depressed and provided above the nostrils, as in the elephant, with a finger-like projection. The entire proboscis is an organ of prehension, used in grasping and uprooting plants.

The eyes of the tapir are small, like those of a pig; the ears moderately long, erect, rounded, and in most species edged with white. The fore feet have four, the hind feet three toes, formed with short, strong claws or hoofs. Ungulates have been divided according to the number of their toes, into two great groups—the odd-toed and the even-toed. In the odd-toed (Artiodactyla) are included the Ruminantia, swine, and hippopotami; in the even-toed (Perissodactyla) we find the modern horse with one toe on each foot, and the rhinoceros with three toes on each extremity. The tapir occupies, therefore, an intermediate position; for the fore feet are even-toed and the hind feet odd-toed.

The tough, comparatively smooth hide is covered with short hairs; in certain American species a short mane is sometimes met with. The posterior portion of the body is more sparsely covered with hair.

In each jaw are six incisors and two eye teeth. There are ten lower and twelve upper molars, each series being divided by a diastema. The molars are uniformly developed.

The American species are simply gray or brown-black in color, somewhat darker on the head, and lighter on the abdomen. The Indian tapir, on the other hand, is black with the exception of a grayish blue spot on the back, resembling a shabrack, for which reason the animal is sometimes called the "shabrack tapir."

Of the habits of the tapir we know but little. The animal inhabits the marshy regions of the tropical forests, derives its nourishment from juicy plants, which it cuts with its incisors and grinds with its molars. Although the tapir is a comparatively strong animal, it can offer no resistance to the leopard, and often falls a prey to the enemy, as our engraving (taken from Illustrirte Zeitung) shows.

[Continued from SUPPLEMENT, No. 1275, page 20397.]

THE MEANS OF DEFENSE OF ANIMALS.—II.*

THE PROTECTION OF THE YOUNG.

IN Lecture I. of this series, we quoted Darwin's definition of the "Struggle for Existence," as including not only the attempt on the part of each individual animal to make its own living, but also its success, or non-success, in leaving progeny behind it:—we considered the chief causes which bring about the struggle for existence; and we propose to-night to treat of one of the means of defense: namely, the protection of the young against the injurious effects of the competition which results from the geometrical rate of increase.

We shall here use the word young to include all stages of animals' lives preceding the adult condition. The young will, therefore, comprise both the egg state and that of the creature which hatches from the egg. Since eggs are, in most cases, passive things, which the beings which hatch from them are usually active, a considerable difference exists in the dangers to which they are respectively exposed, and in the means by which those dangers are overcome or avoided. It is convenient, therefore, to consider, first,

A.—THE YOUNG IN THE EGG.

To how many has the question occurred, Why should an egg be an egg? What is the necessity of each individual's passing through such a stage of existence? It will be worth while devoting a few moments to the attempt to answer this question in its scientific, although not in its metaphysical, aspect. In the lowest and simplest animals no egg exists. The multiplication of the species is accomplished by an actual separation of an individual into two similar masses, so that no distinction can be drawn between parent and offspring. This method is possible, and not disadvantageous, only because of the utter simplicity of life and of the functions of such animals, which are not greatly interfered with in spite of the time which is required for such a process. If, now, in the highest animals, we could conceive of such abnormal cases as the Siamese twins having originated from a division of an ordinary human individual into two similar parts, we can appreciate the very serious disadvantages which would attend such a method. It is true, in a wide, physiological sense, that an approach to this method is found in all animals which bear "living" young, and this approach is accompanied by some of the disadvantages alluded to; but even here the actual process is very different from that existing in Amœbæ and in the supposititious Siamese twins.

It is justifiable to say, however, that reproduction by division of the individual into two similar masses would, in the great majority of animals, be too slow and too dangerous to the existence of the species, and, by restricting the number of offspring to be formed at one time, would render the rate of increase exceedingly low. Moreover (since we must assume that the more complicated an animal is, the longer the time required for such a reproductive method to act), such a method would greatly hamper the movements of the reproducing animals in escaping from an enemy, and in obtaining food, to say nothing of the greater energy required for a complete separation of all the parts and organs of a complex body. The same division of labor which has made the higher animals the complex beings they are, has also operated to restrict the reproductive faculty to eggs and to corresponding sperm cells. We may assert, therefore, that the chief advantage which results from reproduction by means of eggs lies in their relatively small size permitting one individual parent to produce a considerable number of them and, by scattering them over a considerable area, thereby increase the chances of survival, and all this with the least possible hindrance to the parent.

As a secondary advantage possessed by eggs may be mentioned their quiescent nature, being consequently less likely to attract the attention of enemies than if they possessed the power of movement. Further, since most eggs have within themselves food-substances, such as albumen, yolk-fat and oils, to serve as food for the developing embryo, this concentration of food substance is an advantage in that the entire energy stored within the egg may be devoted to the formation of the embryo, since none of this energy will be expended in the search for food.

On the other hand, the very nature of eggs subjects them to two serious disadvantages in the struggle for existence. One of these is their inability to escape enemies by flight: the other is their great palatability as food, so that they are eagerly sought for and devoured by great numbers of animals.

We have already seen that the rate of increase is very different in different animals. This we discussed at some length in Lecture I. Although it was then pointed out that the number of eggs produced by a single female was not the only factor in determining this rate, yet is, of course, of very great importance. We have now to perceive that number and size of eggs are usually in an inverse proportion, a fact which is well shown in the accompanying table, published by Prof. Dean, of Columbia University, in his book "Fishes, Living and Fossil."

	Myxinoid.	Lamprey.	Shark.	Sturgeon.	Teleost.
Size of each egg in millimeters	18	1	50 to 150	2 to 3	1 to 10
Number of eggs in a single female	30	30,000	4 to 12?	7,000,000	50 to 10,000,000
Length of time in hatching	months?	1 to 2 weeks.	5 to 15 months.	1 to 2 weeks.	5 days to 3 months.

The relative sizes of parents must also be taken into account; for the weight of the ovaries of the female and the number of contained eggs is directly in proportion to this—at least, in those animals which liberate all their eggs at very nearly the same time. Size of eggs is mainly dependent upon the amount of yolk or similar food contained within, in addition to the embryonic, or germinal, matter; it has no constant relation to the size of the adult to which it is eventually to give rise. Thus, to recur to the table, the adult Myxine (Hag-fish) developed from an egg 18 25ths inch in diameter, attains a length of 10–18 inches. The Lamprey, with an egg 1-18th the size of that of the Hag-fish, becomes an adult 2 to 3 feet long. Or, to take a number of other instances, the egg of a star-fish is 1-250th inch in diameter; of a cat, on an average, 1-150th inch; of the ordinary milkweed butterfly, 1-20th inch; of a common pond snail (Limnæa), 1-220th inch; yet how different are the sizes of the respective adults developed from them.

Of birds' eggs, Newton tells us, "The size is generally, but not at all constantly, in proportion to that of the parent. The guillemot and the raven are, themselves, of about equal size; their eggs vary as 10 to 1. The snipe and the blackbird differ but slightly in weight; their eggs, remarkably. The eggs of the guillemot are as big as those of an eagle; and those of the snipe equal in size the eggs of a partridge." Hewitson remarks that "The reason of this great disparity is, however, obvious: the eggs of all those birds which quit the nest soon after they are hatched, and which are consequently more fully developed at their birth, are very large. . . It must be added, though, that the number of eggs to be covered at one time seems also to have some relation to their size, and this offers a further explanation of the fact just mentioned with regard to the snipe and the partridge, the former being one of those birds which are constant in producing four and the latter often laying as many as a dozen: but the chicks of each run as soon as they release themselves from the shell."

The effect which the number of eggs has upon the chances of survival in any given species depends, to a marked degree, upon the habits of that species. In those animals which produce enormous numbers of eggs, the parents give the eggs no care after they have been set free. Exposed, in consequence, to many perils, vast quantities perish, but since the total number is so great, the chances of some escaping are increased; but these chances are greater or less according to the details of the egg-liberating habits in different species. If a great many eggs are set free together, it is more than likely that the whole number of eggs will meet with the same fate, be it happy or unhappy. Again, if all the contents of an ovary are deposited in the same place, the chances of survival of a considerable portion of them are less than when they are scattered over a wide area.

Numerous illustrations of animals with great numbers of eggs, that is, from one to two thousand up into the millions for each female parent, are known among sponges, polyps, star-fishes, sea-urchins, many bivalves and parasitic worms, many fishes and quite a number of the batrachians. This brief list reveals the fact that the most highly developed animals have not such large quantities of ova as have the lower ones. Thus, mammals, birds and reptiles, the great majority of insects, of crustaceans and of other arthropods, and not a few mollusks, illustrate this other aspect of numbers. Further, if some of the highest insects (such as the honey-bee) produce great numbers of eggs, and thus seem to form a notable exception to the statement just made, it must be remembered that here the power of reproduction is limited to so few female individuals ("queens") that the number of eggs produced on an average to the total number of individuals of the species is reduced very greatly.

It may well be doubted whether those animals shedding so many eggs have succeeded so well in the struggle for existence as have other species producing few or a moderate number of eggs. Under certain conditions, indeed, it seems certain that only by extreme fecundity could such animals as parasitic worms maintain themselves; for here the adverse chances of completing their life-cycle in the various animals in which they are parasitic are also enormously increased. So much depends on chance whether the young of a tapeworm, for example, passes into the proper animals for its development, that unless there were a very great number of eggs produced by these worms, the chances of further development, taking place would be so small that the species would probably be extinguished. Where the rate of mortality is so high as we have seen it to be in fish eggs, and in the case of such bivalves as the oyster, it is impossible to overlook the enormous waste which occurs by so many eggs being destroyed by climatic influences and by devouring animals. More than that, the production of eggs in great numbers is at the expense of other parts of the female's body, which become emaciated in consequence. It, therefore, follows that where a very few eggs out of a million survive and eventually reach the adult condition, the loss of material on the part of that species is very great.

When the eggs of a given species are small, due to the absence of food-yolk, the consequence is that the period of embryonic development is very short. On the other hand, increase in the size of eggs (usually accompanying a decrease in number) is due to an increased quantity of food-yolk and thereby prolongs the period of embryonic development. Thus, within the limits of a single order of animals (the Decapod Crustaceans), we find two forms, Lucifer and the Crayfish (Astacus) belonging to two different families. The egg of Lucifer measures 0·005 inch in diameter and contains little food-yolk. The development of the embryo occupies 36 hours, at the end of which time there hatches out a larva 0·008 inch long, which undergoes a series a changes during a number of days, before it reaches the adult stage, when it is about an inch long. The egg of the Crayfish has a diameter of 1-12 inch, is well supplied with food-yolk, has the whole winter in which to complete its embryonic development and, on hatching, yields a young animal much like the adult, although but one-quarter of an inch long. In the second year of free life the crayfish may become adult when but 2 inches long, although Huxley thinks that maturity is usually reached in the fifth or sixth year, when 5 inches long.

We have entered into so much detail regarding the number and size of eggs, because there can be no doubt that these factors enter very largely into the struggle for existence of each species. Still, much observation is yet required to determine what are the precise effects of these factors.

We have still to consider another aspect of the protection of eggs, according to whether the species is oviparous or viviparous in habit; that is to say, oviparous, depositing the eggs before they are hatched; viviparous, retaining the eggs within the body of the female until after hatching. In speaking of eggs we instinctively think of those of the oviparous kind, and all that we have hitherto said of the advantages or disadvantages of the egg state or condition applies to this kind; yet the term egg is, of course, just as appropriately used when speaking of the viviparous animals. Among these, one disadvantage mentioned for the oviparous eggs, namely, inability to escape by flight, disappears, for the eggs are not distinguishable from the parent in whose body they lie, so far as the external world is concerned. The fate of the egg up to the time of birth is, therefore, the fate of the mother, and her advantages and disadvantages in the struggle for existence directly determine the fate of the offspring.

We may now glance at some of the protective defenses which different eggs possess:

1. *Modifications of the Egg Itself.*

Thickening or the outer coat, or shell, of the egg acts chiefly to prevent the entrance of injurious liquids from without, and the escape of moisture from within. Eggs so provided endure immersion and drying. Thus Leuckart experimented with the eggs of certain Thread-worms commonly found in the intestine of the horse and other animals, and he found that not only could these eggs resist such liquids as alcohol, turpentine, chromic acid, and various poisons which kill the adult very quickly, but the eggs were even able to develop while immersed in such liquids. This ability to develop under those conditions is due to the great thickness of the egg shell, and is important in the life of the species, since, when these eggs are expelled from the body of the parent, they are quite likely to fall into all sorts of liquids, containing various kinds of chemical compounds, which might otherwise penetrate and kill them.

The Gall-flies (Cynipidæ) insert their eggs into the leaves or the stems of oaks and other plants by means of a slender ovipositor at the tip of the abdomen. The egg is considerably thicker at one end than the diameter of the ovipositor, while the other end is quite slender. The hole which the ovipositor makes in the tissue of the oak is but very little larger than the ovipositor itself; and it would seem therefore rather difficult for this egg to be passed down such a tube. Observation of the process has shown that when the egg is inserted by means of the ovipositor into the hole, some of the contents of the thick portion of the egg are squeezed up into the thin portion; so that the egg then becomes of approximately uniform diameter throughout its entire length. This thickened portion of the egg is inserted first, and therefore lies at the bottom of the hole in the leaf which has been made by the insect's ovipositor. When it reaches the bottom of the hole made by the ovipositor, the contents of the egg naturally sink to the lowest level, and the egg resumes approximately its former shape. The thin end of the egg, however, remains near or at the surface of the oak leaf, and apparently enables some of the oxygen of the atmosphere to be absorbed and to be passed down the hollow neck of the egg into the embryonic part below. This, therefore, is a modification of an egg by means of which the egg, although incorporated at some distance within the tissue of a plant, is assured of an oxygen supply; for, like all other stages of animals, eggs are, in the great majority of cases, unable to develop unless such a supply exists.

2. *Inclosure of the Eggs in Capsules or Cocoons.*

The eggs of many marine snails (Gasteropods) are inclosed within capsules varying very greatly in their shape, size and number. Each one of the egg-capsules of the common conch (Fulgur) of the Atlantic Coast (the whole string of which is sometimes called a "sea-necklace") contains a considerable number of eggs—at least as many as a dozen; and it is quite probable that the protective value of enclosing the eggs in these capsules is to prevent them from being covered over by sand and therefore choked while their development is going on. They also probably protect the eggs from the shock which would result from being carried by the waves and beaten violently against the sand, or against any hard and firm objects. They are probably not protective against animals; since we find that the fishes which are found in the same localities as these egg-capsules are deposited are capable of eating such disagreeable morsels as Sea-urchins, covered all over their external surface with spines, and also are capable

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of crushing the hard shells of the adult Mollusks. In other instances, as, for example, in the Earthworms, the eggs are laid in small cocoons, which are then placed under stones, usually in damp places or in water; and here, also, the protection which the cocoon affords is probably against mechanical injuries, as well as to inclose food for the development of the young Earthworm, a subject to be considered in our third lecture.

Another familiar illustration of protection to eggs by means of a cocoon is that of the Bag-worm so common on our trees.

3. *Attachment to Various Objects.*

Eggs of the common Pond-snail (Physa), of several groups of Dragon-flies, of the Caddice-flies, are frequently attached to objects in the water in which they are laid, either singly or in masses, embedded in a jelly. Wherever this occurs, it is likely that the protection is against the slipping of the eggs into the sediment at the bottom, which sediment, by shutting off air, would be detrimental to the development of the eggs. In other cases, e. g., the Lace-winged Fly (Chrysopa), where each egg is mounted on the top of a slender stalk springing from some object, it has been asserted that the protection is against small mites, and it is supposed that the mites are unable to reach these egg when mounted upon such slender projections.

4. *Nesting.*

The protection which the eggs of birds receive in this respect is too well known to require elaboration, except to point out that here, as elsewhere, it is reinforced, in many cases, by two other factors, namely, by concealment and by the watchfulness of the parent; although the first named is often absent. A number of fishes also construct nests for their eggs; such are the Sticklebacks, several species of which are widely distributed over the earth, and build, at the bottom of streams which they inhabit, a nest consisting of fibrous material or of sea-weeds. In this nest the eggs are deposited and are then watched over by the male, not by the female fish. Records exist in which the male fish has been observed to watch over these eggs both day and night, without leaving them for any cause or purpose whatever, for a period of three weeks to a month, until the eggs hatched and the young fish were able to move about. During this period, it seems to provide for renewal of the water within the nest, so that the eggs may be thoroughly aerated.

Among the Hymenopterous insects we have all stages in the protection of eggs by means of nests—from those cases (Pelopaeus) where the eggs are simply placed in a burrow, or in a hole of some sort, and left to shift for themselves, up to the conditions that we find in the hives of the bee, and in the hills of ants, where the eggs are cared for by the workers, and where, therefore, the maximum degree of protection is obtained.

5. *Carriage on the Outside of the Parent's Body.*

A number of instances of this sort are known, but one of the most remarkable and best known is that of the famous Surinam Toad, where the eggs are carried on the back of the female. Each egg is contained in a small pocket, which, it would appear, is an enormously enlarged skin gland, and is plugged by means of a hardened secretion of that gland. Although this habit has been known for nearly two hundred years, not until 1896 was it learned how the eggs were placed on the back of the female. Observations were then fortunately obtained in the Zoological Gardens in London, from which it appears that at the time of pairing, the male tightly clasps both his arms around the lower part of the female's body, his breast being nearly in contact with her back. The oviduct of the female is protruded for more than an inch, and turned upward over her back, so as to lie between it and the breast of the male. Upon this bag-like oviduct the male appeared to press tightly and to squeeze it from side to side, apparently pressing the eggs forward one by one onto the back of the female. By this movement the eggs were spread with nearly uniform smoothness over the whole surface of the back of the female, to which they became firmly adherent. On the operation being completed, the males left their places on the females, and the enlarged and projected oviduct gradually disappeared." (A. D. Bartlett.) Subsequently, the enlargement of these glands takes place, and the eggs sink into them.

Another member of this group, the Obstetric Toad of Europe, likewise carries the eggs on the surface of the body; but in this case it is the male, and not the female, which performs this function. As soon as the eggs have been extruded from the body of the female and just after they have been fertilized, the male toad catches hold of them by means of his hind feet and pulls them out into a string, four to twelve inches long, since the eggs are held together by means of a jelly-like substance, which is quite elastic when fresh. He then winds them around his hind legs, so that they make several turns, and when he assumes the sitting or crouching posture, the eggs are borne at what appears to be the hind portion of the trunk. The number of eggs which a single toad has been observed to carry varies from eighteen to one hundred and fifty; and since the period of embryonic development is about three weeks, the male is bearing his burden during all of that period. He spends most of the time in a burrow, or in a crevice between stones; but occasionally, at night, comes out, apparently for the sake of bringing the eggs in contact with fresh water, and, therefore, supplying them with fresh air.

The eggs are carried on the under surface of the body of the female catfish belonging to the South American genus Aspredo; their number is very considerable, and they are held in place simply by a gelatinous or glutinous substance.

The male of the Hemipterous water-bug Zaitha carries a load of as many as eighty-five eggs on its back. It seems, from Miss Slater's observations, very recently published, that the male is very averse to carrying the eggs—that the female has to capture and to hold him until she puts the eggs on his back; that the two sexes have fights in consequence, and that in some individuals, at least, after the eggs have been attached to the back, they make no attempt to defend themselves from predaceous foes—apparently preferring death. At times the male succeeds in freeing himself from the eggs; and Miss Slater thinks that such individuals showed evident satisfaction in being relieved of their loads.

On the upper surface of the body of certain sea-urchins (Spatangoids) are deep depressions, from whose opposite borders long spines arch over, and, to a certain extent, interlace with one another. A sort of chamber covered over by the spines is thus formed, and in it the young develop in safety.

In certain star fishes (Pteraster, Hymenaster), the little, hard projections of lime which cover the upper surface of the body are so many tent-poles, so to speak, and a membrane stretched from one to another covers over a chamber or space in which the eggs, and the young hatched from them, are sheltered.

6. *Carriage Within the Parent's Body*

is the condition of viviparity, and is widely distributed among animals. We have already learned its advantages and disadvantages as regards the protection of the young, but we may here point out that sheltering them within the mother's body naturally imposes a limit upon the number which can be produced at one time. Thus, among animals, the highest number known for a single brood is twenty-seven, in some opossums; but the new-born are so small and immature, that they have yet to undergo a considerable development within the pouch.

The presence of the young within the female also tends, in many cases, to impede her movements, and thus to lessen her chances in fleeing from enemies. On the other hand, the eggs, being indistinguishable from the parent, so far as the external world is concerned, receive the fullest degree of protection which the armor, weapons, strength and experience of the adult can afford.

If we sum up the effects of the various means of protection for eggs which we have briefly mentioned, we find that in those cases where parental care does not exist, the protective means are chiefly directed against the effects of climatic changes—of pressure, shock and vibration, due to the action of wind and wave, since few of these defenses avail to deter carnivorous enemies, or to prevent the entrance of parasites. Where parental care over the eggs is exercised, living foes are probably less destructive.

B.—THE YOUNG OUT OF THE EGG.

When eggs hatch, the animal forms which come from them are, for the most part, active and free-living. In this respect they differ from the egg and resemble the adult. Their adversities and their means for defense are, therefore, more like those of the adult, or are often identical with them; so that much that will be said under "Protection Against Living Enemies" will apply also to the newly hatched young, and need not be forestalled here.

In those groups of animals where a larval period follows the egg (and we may mention here the echinoderms, mollusks, crustaceans, insects and batrachians), we have yet to learn the effects which the relative lengths of embryonic and of larval life have upon the struggle for existence in each species. One suggestion seems to be important and may be mentioned. It is "The diversity of ways in which insects are able to feed has also largely contributed to their success in life; and by the very general adoption of metamorphosis the same individual often comes to feed in different ways in the successive stages of its life history, an obviously economic arrangement for the species, since the drain on each of the food supplies is lessened. Moreover, the adoption of metamorphosis, by storing up food during larval life, and so largely obviating the necessity for feeding in the perfect stage, enables the image to devote full attention to the breeding function and largely to increase the number of eggs." (G. H. Carpenter.) A familiar illustration is that of the butterflies, which feed upon juices of flowers and other plant parts, their food being always liquid in form; while their caterpillars devour the solid leaves or stems.

Yet this suggestion will reach but a little way. Even among insects there are large groups, such as the tiger beetles (Cicindelidæ), ground beetles (Carabidæ) and whirligig beetles (Gyrinidæ), in which both larvæ and adults have practically the same food, namely, living animals. We may, perhaps, add that when larvæ and adults live in different situations, or in different media (such as in the water in one stage, and on land, or in the air, in another), they similarly lessen the drain on the food supply, even though it be of the same character in the two media. Here we may cite the dragon flies.

The suggestions made are but general, and apply to but few cases. Our problem is, not how larvæ and metamorphosis came into existence, but, having come into existence, what is the effect on the stuggle for existence of a longer or shorter larval period in each species?

NEW METHOD OF DIMINISHING THE FORCE OF WAVES AND SURF.

AN Italian gentleman, Baron Benvenuto d'Alessandro, living in Paris, 62 rue Bossière, has invented a new method of protecting vessels at sea, entrances to harbors, light-houses, etc., from the force of waves and surf, which he claims is more efficient than the use of oil.

His invention consists in retaining on the surface of the water an unsubmergible floating net by means of outriggers when used to protect vessels in storms at sea, and by attaching it to buoys when used to protect light-houses, hydraulic works in construction, entrances to harbors, etc.

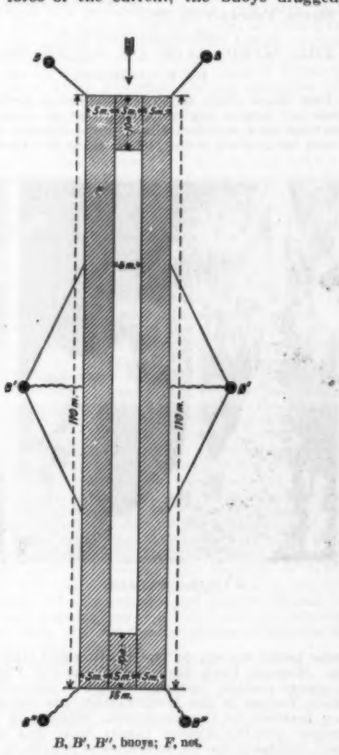
He bases the idea of his invention upon the principle that in covering the surface of the sea with a thin, flexible, light, and floating body of whatever nature, the part covered forms a crust under which the molecules of the imprisoned mass of water can not move in the same manner as the surrounding body of uncovered water, the result being that even the most violent waves, upon reaching the edge of the crust, instead of climbing over it, of breaking or of destroying it, will pass under it as if there were a fall or difference of level, become flattened out, and lose much of their force.

The net used in the recent experiments at Havre was made of a thin hemp fiber, knitted in square meshes of 4 centimeters (1·57 inches), and afterward waterproofed by the application of a solution of powdered cork and pure rubber. The material of the finished net was 3 millimeters (0·12 inch) in thickness and light, weighing only 120 grammes (4¼ ounces avoirdupois) per square meter (10·76 square feet). It was constructed by the Société Industrielle de Telephones at Paris.

The net was 110 meters (360 9 feet) long and 15 meters (49·2 feet) wide, made in four sections, securely fastened together. The two outside sections were 5 meters (16·4 feet) wide throughout the whole length of the net. The middle sections were also 5 meters (16·4 feet) wide, but extended only 10 meters (32·8 feet) from either end, leaving an open space in the center of the net 90 meters (295·27 feet) long and 5 meters (16·4 feet) wide. The inventor's reason for constructing the net with an open space in the center is that in his numerous experiments with the net made in this way, when used for the protection of entrances to harbors, etc., he found the surface of the water inclosed in the free spaces to be always calm, as if it were actually covered by the net. The net with the open space is only used when it is anchored. For the protection of vessels at sea, the net is made solid.

The accompanying sketch shows the dimensions of the net and the arrangement of the buoys by which it was held in position.

To illustrate the efficiency of the net in protecting hydraulic works in course of construction from the effects of a heavy surf, Baron d'Alessandro, about three weeks ago, placed his net off the middle of the north jetty of the new avant port of Havre, which is now finished for about 400 meters. The buoys, *B B*, were anchored in 50 feet of water, at high tide, in a position to secure the head of the net in the direction of the prevailing westerly winds and perpendicular to the jetty; the buoys, *B' B'*, being about 100 meters (328 feet) from it. At first, only four buoys were used—*B B* and *B' B'*—but the anchors not being heavy enough to stand the force of the current, the buoys dragged,



B, B', B', buoys; *F*, net.

allowing the net to be slackened and take the form of a crescent. Afterward, the buoys, *B' B'*, were added and the weight of the anchors increased. During a heavy westerly gale, recently, the net was held in position; but, on account of the seas hurling themselves against the jetty and breaking over it, it was impossible to approach near enough to observe the effects which the net produced upon the portion of water protected.

Mr. d'Alessandro is not discouraged by the unsatisfactory results of his experiments at Havre and intends in the near future to place his net in another position, in which, while being exposed to the heavy seas, it can be readily seen from the shore and its action judged.

Other trials have been made of the floating net; in 1891 at Quiberon, Department of Morbihan, and in 1892 at Cherbourg. The following are translations of the report made by Captain Lequellec, chairman of a committee of the Société de Sauvetage, at Quiberon, to the president of the Société Centrale de Sauvetage, at Paris, and of notes upon the trials at Cherbourg taken from Baron d'Alessandro's pamphlet called Le Filet Flottant:

Quiberon, November 14, 1891.

The President: I have the honor to call the attention of the Central Life-Saving Society to the trials which were made in our waters of a floating net, which is intended to be used as a protection against the force of heavy seas and as an advantageous substitute for oil. This net, which is very simple, is covered with a composition which renders it buoyant and unsubmergible and has a surface of about 1,000 square meters (1,196 square yards).

I, together with the captain of the life-saving boat, Mr. Le Chanjour, assisted the inventor, Baron d'Alessandro, during the different trials which have been made since September 12. He has shown us many different ways of placing the net. At first it was anchored at each end, lengthways across the waves;

but, finding that the resistance was too great and that it was impossible to continue the trials, we changed it.

On November 9, we anchored one end of the net head to the wind, leaving the other free to float in the breakers. During the evening of November 10, the results were favorable. The waves did not break on the surface of the net, and the effect was absolutely the same as if oil had been used.

We also observed that when the boat was under the lee of the net the sea was smooth, and the contrary was true when the boat was withdrawn from its shelter.

During the trials in company with the Baron and the captain of the boat, I have been able to see that this net would be of great service to our navy and merits further attention.

Very respectfully yours, LEQUELLEC,
Chairman of the Committee.

LE CHANJOUR,
Captain of the Life-Saving Boat.

Signatures were legalized by the mayor of Quiberon.

NOTES OF THE TRIALS AT CHERBOURG.

At Cherbourg, the same nets were anchored in the open, with anchors, chains, and iron buoys, and exposed to the force of the wind and sea.

(1) From the 21st to the 30th of January, 1892, calms and heavy seas.
(2) From the 28th to the 29th of April, 1892, heavy seas.
(3) During the whole of March 3, 1892, heavy seas.
(4) From the 14th to the 15th of June, 1892, heavy seas.
(5) From the 12th to the 14th of October, 1892, storm.

The nets in all these trials had the effect of calming the seas and kept afloat during the whole time, without changing position or receiving any damage.

The results of any future experiments which may be made by Baron d'Alessandro at Havre will be the subject of a supplementary report.

A. M. THACKARA, Consul.

Havre, February 23, 1900.

THE WIND CAVE OF SOUTH DAKOTA.

By E. O. HOVEY.

THE Black Hills, in the southwestern part of South Dakota, form a region which has so many natural beauties and wonders that it must become a popular resort for tourists from the East, as its attractions become better known to the reading and traveling public. Harney Peak and the Cathedral Park in the southern portion, Spearfish Cañon in the northern and Mato Teepee in the northwestern are the most striking features of the superficial scenery in the Hills proper, but the district boasts some fine caverns as well, the most readily accessible of which is the Wind Cave, in the southeastern border region. This cavern is said to be by far the largest in the Hills and certainly is one of the most beautiful in the world. It is situated ten miles north of the Hot Springs and is reached by comfortable stages, which leave the principal hotels every morning during the summer season.

The drive is one of the most attractive of those in the vicinity of the Hot Springs, though the country does not seem to be very fertile, most of it being used for pasturage and cultivated ranches being few and far between. Before reaching the cave the road affords an extensive view over the country, having risen 640 feet above the town of Hot Springs, which lies in a valley. Toward the northwest the Black Hills proper bound the prospect, and the darkness of the spruces and other coniferous trees which cover them and present a marked contrast to the light color of the plains shows the appropriateness of the name. The Bad Lands can just be discerned in the distance. Close at hand the beds of the rock zones forming the rim of Hills are seen to dip gently outward or away from the Archæan core of the region and to show abrupt escarpments facing inward. We perceive, furthermore, that we have crossed the famous Red Valley, which is carved out of red clays of Triassic age and extends so continuously around the Hills that it once formed the main avenue of travel for Indians traversing the country and was known to them as the "Race Course."

The halt at the frame hotel at the entrance to the cave for the important preliminary of dinner gives one an opportunity for learning something of the history of the property, before beginning the investigation of its wonders. The cave was first discovered in 1877, by a notorious stage-robber and outlaw called "Lame Johnnie," but the discoverer disappeared from the region with assistance of a rope in the hands of a committee of his neighbors who had been victimized too long and the existence of the cave seems to have been forgotten. Seven years latter a cowboy was riding through the gulch near the spot where the hotel now stands, when his horse became frightened at the noise made by a strong current of air which issued from an opening about eight by ten inches in size in the bottom of the ravine. Examination showed that this opening led into a cavern, which was christened the "Wind Cave" on account of the circumstance which led to its discovery. This current or air, however, which blows outward in summer, or when the temperature outside is above that within the cave and blows inward in winter, when the cave is warmer than the outside air, is a feature common to all large caverns and is not peculiar to this one.

The opening being too small to admit a man, another entrance was made near by by blasting away the rock and the first explorations were made, but these extended only a short distance before the end was thought to have been reached and the cave was supposed to be of small size. Nothing further was done until 1890, when portions of the surface were located as mineral claims and men were put to work making openings and exploring in every direction. The managers state that since that time more than one hundred miles of passages have been explored without reaching the end, and that not less than 3,000 chambers have been discovered, varying in size from those twelve feet square to composite ones covering three acres or more. Of the fourteen routes which have been made out, three have been made accessible to the public, and some $25,000 in all is stated to have been expended by the Black Hills Wind Cave Company in excavating passage ways and in building paths, bridges and stairways.

Having learned this outline of the history of the cave we made ready for the descent into its depths, our party consisting of twenty or more ladies and gentlemen and three guides. The cavern is so dry that one needs no special costume for the trip, the only precaution necessary to take being to avoid the melted paraffine dropping from one's own or his neighbor's candle. The present entrance to the cave is by means of a hole artificially formed near the bottom of the little gulch on the brink of which the hotel stands. The steep descent through the entrance shaft is illuminated by candles placed in niches out of the way of the strong current of air which is rushing to the surface, but fifty feet below the mouth the wind has ceased and we go forward in the light of our own candles. We have passed the barren vestibule of the cavern and some of the party are beginning to express their admiration of the formations incrusting the walls, but our genial guide, Mr. John Stabler, tells us that this is nothing and that we have not even entered on the named chambers of the route we are to take.

The heavily bedded limestone, which is of carboniferous age, dips toward the southeast at angles of from five to ten degrees and is traversed by persistent vertical joints or fissures the trend of which is about northwest. These fissures are approximately parallel to one another and are from 50 to 300 feet apart. They are connected by short cross joints or crevices which are not persistent. The main fissures have been irregularly widened by the action of subterranean waters and the same agency has served to excavate narrow, uneven connecting ways along the transverse crevices. The United States Geological Survey has determined the elevation of the mouth of the cavern to be 4,040 feet above tide and the lowest level is said by the owners of the cave to be five hundred feet below the mouth. Eight tiers or sets of chambers lie one above another within this space and each is characterized by the kind of cave formation to be found therein. Stalactites and stalagmites are thought to occur only in the uppermost tier, where trickling water may be found, the origin of which is probably some ravines to the east of the mouth. These formations are very delicate and beautiful, as may be judged from the accompanying view of the Fairies' Palace, but they are on a small scale as compared with the drip formations to be found in some eastern caverns and they are not exhibited to the general tourist. The three routes now open to the public are known as the Garden of Eden route, the Fair Grounds route and the Pearly Gates route, the second including part of the first and the third including parts of the others.

The numerous chambers have received their names from various circumstances and the points of rock which project here and there as the relics of erosion have been christened from their fancied resemblance to some familiar object of nature above ground. Traversing the Bride's Chamber we passed by the Prairie Dog and his Mound, and soon found ourselves in the Snow Ball Room. This last is in the second tier of chambers and is characterized by what is really the most curious formation in the cave. It is called frostwork by the guides, and consists of aggregates of very slender acicular crystals of snow white calcite (or more probably aragonite) which are from one-fourth of an inch to two inches or more in length. These tufts occur in fissures and on other points which are particularly exposed to whatever currents of air may circulate through the cave, but their origin is one of the problems of the cave. They show no marks of deposition by water, but look more like efflorescences. Beyond the Snow Ball Room lies the Post Office. This room is in the third tier from the top and has received its name from the fact that its walls and ceiling are lined with a particularly regular development of the curious "box-work" which one soon learns to regard as the characteristic formation of this cave and which has received its very appropriate name from the guides on account of its resemblance to small empty boxes.

Prof. J. E. Todd,* the State geologist of South Dakota, has offered what seems to be the rational explanation of the origin of this formation. The substance of his theory with some slight modifications is about as follows: The country rock is an impure limestone which has been cracked into small polygonal blocks from two inches to a foot across which are more or less rectangular in section. The intervening crevices are usually very narrow, less than a sixteenth of an inch wide, though sometimes the width is three or four times as great, and all have been filled with secondary calcite. Such cracked and rejoined rock is found exposed upon the surface in the vicinity of the cavern, and is seen in the loose blocks of limestone lying about within its depths. Within the cave the processes of disintegration of the limestone between the seams of calcite granulate it, and the grains of calcareous sand run out, leaving the calcite plates inclosing empty polyhedral spaces. Another generation of calcite has formed on both sides of the freed plates which is crystalline in character, but usually without distinct termination, though crystal faces are often to be seen along the edges of the plates. All stages in the process described may be found, and although the boxes are sometimes closed, that feature seems to have resulted from a later deposition of calcite and it may be assumed that they were once open for the escape of the inclosed material. The floors of the chambers are often covered with calcareous sand.

Prof. Todd reports having found fossil plants, corals, and mollusks, suspended in the open meshes of the boxwork and coated with the same generation of crystalline calcite as the sides of the boxes. The writer has seen no explanation offered for the presence of the

FAIRIES' PALACE.

SCENES OF WICKALOW.

THE COUNCIL CHAMBER.

FAIR GROUNDS.

THE WIND CAVE OF SOUTH DAKOTA.

coating of calcite and the absence of stalagmites and ordinary stalactites, and he would suggest that this condition may arise from a nice adjustment between the scanty supply of calcareous waters and the evaporation in the dry atmosphere of the cavern which prevents the water from dropping to the floor. The plates of the boxes would cause the meager supply of water to spread out and leave its load of calcium carbonate as a thin sheet on the old plates or seams of calcite. This boxwork is seen hanging from the ceiling and clinging to the walls in the "Scenes of Wickalow" and the "Council Chamber." In the lower tiers the calcite plates are coated with knoblike excrescences of concentric structure which have suggested the name "popcorn work" for the formation. The boxwork and popcorn work are heavier in the lower than in the upper portions of the cavern.

Continuing our journey from the Post Office we soon find ourselves in the Red Hall, which owes its name to the color of the walls, and beyond that we enter the White Room with its dazzling surfaces of pure white frost work. Passing through the Opera House with its natural seats and stage we look up from the narrow gorge we are traversing and see, sixty-five feet above us, a point of rock jutting out to which the name of Devil's Lookout has been given, another illustration of the tendency of the people of some of our states to dedicate to the devil any particularly striking or beautiful phenomenon of nature. Going without special comment through Milton's Study and Sampson's Palace, we pause for a moment in a room which is called Swiss Scenery, because its pinnacles of rock bear a fancied resemblance to the appearance of the Alps. Beyond this we enter the Queen's Drawing Room, which is impressive from its size and comparative regularity. The M. E. Church has received its name from the natural pulpit which it contains and from the fact that a Methodist preacher held divine service there once. The denomination of the "church" would be liable to change, however, with that of the minister who occupied the pulpit.

In Odd Fellows' Hall the guide points out in the ceiling three ellipsoidal concretions which are joined in such a way as to make a good imitation of the badge of that society, and tells us about other chambers in

* A Preliminary Report on the Geology of South Dakota, p. 491, 1896.

the cave which contain natural imitations of the badges of other secret organizations. We are now walking along the path known as the Turtle Pass, on account of a block of stone beside it which has been worn into the shape of a great sea turtle with head erect, and we soon arrive at the cross roads, the point from which the routes leading to several parts of the great cave diverge. Our objective point is the Fair Grounds and we keep on to the left, passing through Sumner Avenue and Dewey's Palace to the Kimbal Music Hall, where we halt to give the guide opportunity to prove to us the musical properties of several plates of rock in the side of the room by striking them so as to produce some of the tones of the scale. Descending through Whitney Avenue we find ourselves in Monte Cristo's Palace, said to be 450 feet below the mouth of the cave, a beautiful room the walls of which glisten as if coated with gems, so bright are the reflections from the facets of numberless crystals. Climbing on down to the eighth tier or level we traverse in succession the Assembly Room, the Tennis Court and the Marble Quarries before we reach Johnstone's Camp Ground, which is the room the mind-reader Johnstone used as his headquarters during the three days and nights which he spent in the cavern while hunting blindfolded through its winding passage ways for a pin, a search which was finally successful. After seeing the parlor, we squeeze through the narrow portal called the Ticket Office and reach the "Fair Grounds" which is a comparatively barren room said, with its branches, to cover an area of not less than three acres. This if the end of our route and we turn back in regret, traversing once more the rooms through which we have come and arriving again at the entrance after three hours of delightful existence in the cool, pure, bracing atmosphere of the cavern which has enabled us to walk several miles and take much unusual exercise without fatigue. One member of our party was a farmer seventy-eight years old who had come from his home near St. Joseph, Mo., for the purpose of making the tour of the region about the Hot Springs.

According to Mr. Stabler's observations the uniform temperature of the atmosphere of the cave is 45° F., winter and summer, a value which accords very closely with the mean annual temperature of the region. The cave seems to be barren of life, and there is practically no water for its support.

CATTLEYA × MAGGIE RAPHAEL (DOWIANA AUREA ♀, LABIATA TRIANÆI ♂).

THERE is a special interest about this fine hybrid, which we here illustrate, raised by H. S. Leon, Esq., Blethley Park, Bletchley, and shown at the Royal Horticultural Society. As it is not only a very fine and distinct hybrid, but it also serves to check an error in a previous record, viz., Cattleya × Massiliensis, which was said to be of the same parentage as the one now under notice, though the matter was always considered more than doubtful on account of its exhibiting so little trace either of the yellow color or the form of C. Dowiana aurea. C. × Maggie Raphael has the yellow color of C. Dowiana aurea, with the addition of a bronzy-rose tint toward the edges of the petals, and a number of purple spots along the veining on each side of the mid rib. The lip is of a rich purple color, lighter toward the margin and apex, and with some yellow lines running from the base to the center. It is a very distinct and beautiful flower.—The Gardeners' Chronicle.

THE POLITICAL ORGANIZATION OF THE FILIPINOS.

By R. L. PACKARD.

THE following article is taken from a study of the village organization, as it existed in the Philippine archipelago before the advent of the Spaniards, and as modified by Spanish policy, by Prof. Blumentritt, the German ethnologist whose works upon the Philippines are well known to scholars. The wisdom and adroitness of the Spaniards in adapting the ancient conditions to their own needs will be apparent. Doubtless most Americans will be surprised to learn that the Filipinos have such a complete political organization as to elect their officers, which they were accustomed to do before the United States came into existence as a nation.* Prof. Blumentritt's paper is based upon early Spanish accounts of the natives and modern observations, and was written about twenty years ago.

When the Spaniards under Legazki arrived in the Philippines in 1565, they found no united or strong state but the archipelago was divided into innumerable small governments, each of which consisted of only one community, or village. But wherever Islam had taken root, as in Mindanao, Sulu, and the Bay of Manila, these governments were larger, that of the sultan of Manila extending along the shores of the bay, while the domain of King Lacondala, of Tondo, comprised in a large are of a circle the properties of the Sultan of Manila, and also extended northward into the province of Pampanga. In the present province of Bulacan there were three sultans, vassals of Lacondala, who were descendants of the Malays of Borneo and Negrito women; all the rest of Luzon and the Bisayas were parceled out among the little governments mentioned above. In Sulu and Mindanao there were also large sultanries.

These pagan governments were called barangays or balangays, and there are to-day certain vessels of this name in the Bisayas and Mindanao, from which circumstance it has been suggested that the inhabitants of each barangay community were the descendants of the crew of the barangay boat in which the Malay ancestors had reached the Philippines. The barangays were not large, many comprising only a hundred individuals. Their chiefs were called dattos in the south and manguinoos in the north. The dignity of datto was hereditary in certain barangays; in others, particularly in the north of Luzon, wealth and warlike exploits gave that sovereign dignity to the most important persons. In communities where the government was hereditary, primogeniture regulated the succession to the throne. If there was no son, the title of datto passed to the daughters, and in the absence of daughters the nearest relatives of the defunct prince assumed the government.

The population of each barangay was generally divided into seven castes, viz., the family of the datto; the free men, or petty nobility; the freedmen, the vassals and clients of the dattos, the serfs, the demi-slaves, and the complete slaves.* The Spanish dominion promptly put an end to all these distinctions. The numerous small colonial states were first suppressed partly to facilitate administration and destroy the power of the dattos, and partly in order to assist the religious conquest, as the Spaniards called it, whose proselyting efforts were hampered by the lack of priests. Consequently the inhabitants of several barangays were compelled to unite into one common village or pueblo, but the members of the different barangays soon gathered themselves together in the new community so that this became divided into quarters which took the old name of barangays. But through the able measures of the Spanish government, the memory of a common origin and of political independence gradually died out among the members of the barangays. In order not to render the dattos hostile to the new state of things, their original dignity was left them with the Hispano-Filipino title of cabeza de barangay, or barangay chief, although their influence in the new pueblo was already considerably lessened by mutual rivalries. But their previous rights were reduced to a minimum, all executive power was taken from them in exchange for which they were charged with collecting the personal tax or tribute of the Spaniards, for which they were held responsible although they were themselves exempt. Thus the interests of the Spanish government and of the ex-dattos coincided. Besides, in order to accustom them better to their new situation, a number of honorary distinctions were accorded them, among others the title of don. The dignity of cabeza de barangay was hereditary or elective, according as the corresponding barangay had followed one or the other custom in old times, for it was the Spanish policy to leave the national organization intact as far as possible. At the head of each of the new communities was placed a chief or mayor with the title of gobernadorcillo or capitan, who was chosen for a certain period by the cabezas de barangay and, naturally, from among their own number. These latter also formed the municipal council, and filled the places of the different communal functionaries who will be specified later on. This measure effaced the difference between the various barangays which then became mere fiscal units, while their former dattos governed every barangay of the pueblo in virtue of their authority as gobernadorcillos. Just as the cabeza de barangay was responsible for the tribute of his quarter, so the gobernadorcillo was made responsible for the tranquillity of his village and its tribute as well as the performance of the annual personal labor required by Spanish law. The election of the gobernadorcillo had to be ratified by the Spanish Governor-General and could only take places in the presence of a Spanish functionary or curé, or at any rate some Spaniard or other. Thus the gobernadorcillo was the ancient datto or manguinoos, and to this day the Tagals call the gobernadorcillo "manguinon."

CATTLEYA × MAGGIE RAPHAEL.

In order to destroy completely the power and influence of the ex-dattos, the Spaniards suppressed the different classes of serfs and slaves whose interest it was expected would therefore, attach them to the Spanish dominion. All natives, except the families of ex-dattos and perhaps also the mahaldicas or petty nobility, were called upon every year to perform a certain amount of public labor for the Spanish government, such as work upon roads, bridges, etc.

As is easy to see the new communal organization is hardly to be distinguished from that of the ancient clan which existed during the time of independence. The power of the ex-dattos had certainly diminished after the Spanish conquest, but every clan still remained undivided in its barangay, and its former chief still remained separated from his former subjects by a profound social abyss and still inspired them with great respect. If the Spaniards had been forced to leave the Philippines a few decades after the conquest the villages or pueblos would have split up and the ancient class or barangays would have revived with their former chiefs, because the inhabitants of a pueblo did not regard themselves as members of a single community but each clan formed a community apart which only united externally with the other clans or barangays.

The Spanish government started from the principle that the barangay was a fiscal unit, and decreed that each barangay should consist of not more than from 50 to 100 families paying the tribute. Thus the development of the villages or pueblos increased the number of barangays each of which was placed, naturally, under a cabeza de barangay. The dignity of this chief was no longer hereditary in the new barangays nor did it any longer pertain to the families of dattos, but any rich man whose ancestor had, perhaps, been a slave at the time of the conquest, might acquire it. As the new cabeza shared with the old the privileges of exemption from the tribute of having the title "don," etc., and as these privileges were transmitted to the eldest son, a new nobility of functionaries thus came into being which was at first inferior to the old in consideration but which soon became confounded with it exactly as happened to the patricians and nobility in Rome at the time of the Gracchi. The old and the new nobility became merged because the families of the ex-dattos and the new nobility had the same interests, especially in the election of municipal functionaries. The members of this nobility were called principales by the Spaniards. In 1570 the Spaniards introduced the first direct or poll tax in Mindanao and soon after extended it to the entire archipelago. This poll tax was called tributo by the Spaniards and amounted to 8 silver reals (about 88 cents) per couple of individuals, i. e. for a man and wife, each individual being therefore taxed 4 reals (or 44 cents). The former was called the tributo entero or whole tax and is what is usually meant in Spanish works when the term tributo is used. Children under sixteen and adults over sixty were exempt from this tax. The formation of new regiments in 1590 compelled the Governor-General of the time to raise the tributo to 10 reals, which was payable in kind, rice, wax, gold dust, etc. To this must be added 1 real as a land tax or dues to the church which was called the sanctorum, and a municipal tax called the caja de comunidad. The total tax for a couple in modern times is 15 pesetas (about $3.00) of which a portion are the municipal and sanctorum taxes, the real tribute being only the remainder after deducting those, but when the term tributo entero is used it includes the total without distinction. The Chinese and their half bloods pay a higher tax than the natives; the whites and their descendants generally pay no tributo, nor do soldiers who have served a certain number of years, nor natives who have rendered distinguished services in improvements in agriculture and industry nor the descendants of the Christian princes of Cebu. [Nor the cabezas de barangay. See above.] The caja de comunidad pays the school expenses, the salaries of the teachers, the vaccinators, jailers and clerks and also pays for keeping the public buildings in repair. The food of the prisoners in the jails is also paid for out of this tax.

The sanctorum is the salary of the curé who receives 180 pesos (about $180) for every 500 couples who pay the whole tax in his parish, a circumstance which makes the all-powerful influence of the clergy serve the interest of the royal treasury. The curé acts as a controller to prevent any cheating in the payment of the tributo. This tax is levied by each cabeza de barangay which usually consists of 50 taxable units or 100 individuals subject to taxation. Insolvents are required to pay in kind or work out their taxes and are employed in the large towns in sweeping the streets and in similar work, but this latter rarely happens notwithstanding the laziness of the natives. The gobernadorcillos and cabezas retain 2 per cent. of the taxes received.

Besides these taxes, the natives are required to do forty days public service a year, working on bridges and roads, and in carrying the baggage of white travelers. The natives are also night watchmen and mail carriers. The principales and native officials are exempt from personal service. Anyone can purchase exemption from this service by paying 15 pesetas ($3) into the municipal treasury.

The autonomous village is called a pueblo. One which has not yet attained autonomy but forms one community with a pueblo is called a barrio, visita, or anejo. Each village has a public edifice like the rathhaus in Germany, which is called the tribunal, in which are held the sessions of the municipal council and of the gobernadorcillo's court. This building also serves as a public station when there is no prison in the village. If the government employes in the capital of a province have their offices in the tribunal, the building then takes the name of the casa real, the literal meaning of which is royal house or king's house.

The village dignitaries are the gobernadorcillo, whose functions are something like those of a French maire, and who is generally called capitan. He has a principal lieutenant, two sub-lieutenants, several officials with the title of judge, who attend to suits or differences about agriculture and cattle, and try police disputes, and, finally, the alguazils, who are captains or officers of the police force. These offices are all elective. Each visita also has its lieutenant, judge, and alguazil. Before describing the rights and duties of these magistrates, it is desirable to give some further details of the present functions of the cabezas de barangay and their privileges.

The division into barangays is always in force, fifty families forming a barangay, at the head of which is a cabeza or chief, as has already been said. When the position is not hereditary, the cabezas are elected, and almost always from among the principales. Usually, at the expiration of his functions, the cabeza is re-elected. If he resigns, his son is usually chosen to fill his place, so that the function is virtually hereditary.

The term of service is from one to three years in different provinces. Besides collecting the taxes and superintending the performance of personal services the cabeza is responsible for the public peace in his barangay and settles disputes in matters concerning the village.

The cabezas are, as has been said, exempt from taxes and personal service. They have the title of "don," which raises a native, in the view of his countrymen, to the rank of gentleman. These privileges extend to the wife of the cabeza, to his eldest son, and to his eldest adopted son if he has no children.

* The Filipinos had alphabets of their own, and could read and write before the Spaniards discovered the islands, doubtless, therefore, before the discovery of America.

* This aristocratic social condition antedates any tradition and is accounted for by a creation myth which resembles those animal myths found in various parts of the world, among the American Indians for example, in which men and animals are on the same footing. It tells here how men were originally separated into classes by the first pair.

Noble native families, dating from the conquest and descendents of the ancient dattos, enjoy these privileges as a matter of course, without restrictions, and without the condition of performing the duties of a cabeza. The novus homo who is elected cabeza preserves the title of don even after leaving office, and is numbered thenceforward among the principales.

In order to be eligible to the important position of gobernadorcillo the candidate must be an "Indian," that is to say, a Malay native or Chinese métis (i. e., son of Chinese father and Malay mother), he must be 25 years old, must know how to read and write, and must have filled the office of lieutenant or cabeza de barangay, and the taxes of his barangay must not be in arrears. For these reasons the office is monopolized by the principales. The gobernadorcillo is elected for one year, and the election takes place in the following manner.

The electors are the gobernadorcillo who is about to resign, six cabezas de barangay, and six ex-gobernadorcillos who have been cabezas de barangay, making thirteen voters, who are all, it will be noted, principales or nobles. None of these electors is the subordinate of any royal functionary or of the curé, but the president of the electoral board must be a Spaniard—the governor of the province or his substitute if possible. The curé of the village has the right, although it is not his duty, to attend the election, which must be held in a public building, such as the tribunal or a school, and not in a private house nor in the parsonage. The thirteen electors choose two candidates, to whom the outgoing gobernadorcillo is added. The president makes a report of the election, which is signed by all the electors,* the curé and the clerk, in which he indicates which of the two candidates he considers best suited to the position, and this report together with all the documents bearing on the election are sent to the governor-general at Manila. The candidate presented in this way is nearly always appointed by the government. In the Bisayas the provincial governors are delegates of the general government on this occasion and confirm the election themselves.*

The badge or staff of office of the gobernadorcillo is a gold headed cane with a silk tassel, which he always carries and does not lay aside even while at meals.

Besides his qualities as political head of the pueblo—and as such responsible for troubles with the government—and director of its commercial affairs, the gobernadorcillo is also a judge, taking original cognizance of cases not exceeding 25 pesos. He also makes the first investigations in criminal cases and hands his report, together with the criminal, over to the Spanish authorities. It is one of his functions, too, to see that the people of his village attend to their religious duties, principally the rites of baptism and marriage. His means of coercion are usually the rod and imprisonment, which are also the means employed by the judges in enforcing their decisions. If the village is a port and is not the residence of a Spanish governor, the gobernadorcillo is also the captain of the port.

His position, in the eyes of the natives, is rather a distinguished one. He is always accompanied by an escort composed of his lieutenants, clerks and others, while if he goes far from the suburbs he is escorted by the national guard, and he has a place of honor in church.

The election of the lieutenants and judges takes place in the same way as that of the gobernadorcillo except that no approval from Manila is necessary. Only those who have held the position of gobernadorcillo can be superior judges. The alguazil, mayor, or chief of police, has charge of the principal police station and watch houses. He also provides European travelers with escorts.

The is no session of the municipal council in the sense in which we understand the term. The administration and direction of the village are entirely in the hands of the principales and as they are controlled by the curé it follows that all the threads of the municipality are held by him, provided, that is, that he be Spanish, for the colored ecclesiastics have little consideration.

There is a sort of national guard or militia called quadrilleros for preserving the public peace and protecting the people against pirates, bandits, and the wild tribes. They are undisciplined and poorly armed.

Newspapers in Russia.—Consul Smith sends from Moscow, April 14, 1900, the following data as to publications in Russia:

Periodical journals and newspapers issued in the Russian language	631
In the Polish language	65
In the German language	42
In the Estonian language	11
In the French language	8
In the Latin language	9
In the Armenian language	6
In the Hebrew language	2
In the Caucasian language	5
Total	779

Uruguayan Trade in 1899.—Minister Finch, of Montevideo, under date of April 9, 1900, sends a statement of the trade of Uruguay in 1899, from which it appears that the total imports were $25,551,789, against $24,784,360 in 1898; and the exports, $62,125,952, against $55,061,276 in the preceding year. The chief increases in the imports were in raw materials, machinery, and "soft goods;" in the exports, gains were noted in slaughterhouse products.

*The German savant Jagor witnessed an election on the island of Samar. His account differs slightly from the above and is as follows: He says (Reisen in den Philippinen): The election took place in the communal hall ling (tribunal). The representative of the Spanish governor sat at the head of the table as president, with the curé on his right and the clerk, who was also interpreter, on his left. All the cabezas de barangay of the village, the outgoing and the ex-gobernadorcillos then took their seats. Six cabezas and as many ex-gobernadorcillos were first chosen by lot to serve as electors, the outgoing incumbent making the thirteenth. All but the electors then left the room. After the president had read the election law and cautioned the electors to perform their duties conscientiously, the latter advanced to the table, one after the other, and wrote the names of three candidates upon a ticket. The candidate who has the greatest number of these votes is thereby elected gobernadorcillo for the ensuing year, unless the curé or some elector objects, the election being subject to confirmation at Manila. This confirmation rarely fails, because the curé would prevent an unsatisfactory choice. The other officers are elected in the same way. Everything was done with decorum.

TRADE NOTES AND RECEIPTS.

Sealing Wax with Wick.—In an earthen vessel melt at moderate heat:

Venetian turpentine	30 ounces.

to which add

Shellac	1 pound 20 "

stirring with a wooden stick, until same has also melted. Meanwhile grind:

Genuine Bologna chalk	6 ounces.
Magnesia	6 "
Vermillion	1 pound 12 "

into a very fine powder and introduce this into the mass. After the mass has been thoroughly mixed, pour in:

Turpentine	7 ounces.
Mastic dissolved in turpentine	3 "
Peruvian balsam	3 "

Heat again and mix well, whereupon the finished sealing wax can be poured into moulds.

The wick consists of 6 to 10 cotton threads, which are saturated with wax or stearine. The wicks thus prepared are stretched in specially made moulds, whose open part is provided with a funnel, through which the sealing wax mass is poured in.

The wick itself is stretched firmly.

For blue, fine ultramarine blue is used, for yellow finely prepared perfectly anhydrous chrome yellow, for black, very finely prepared ivory black.—Oel- und Fetthandel.

Preparations for Washing Cattle, Etc.—With the different methods of washing cattle which are conducted by farmers in spring or autumn, currying is considered an important factor. The parasites are known to be chiefly lodged in the cutaneous scale and hair tangles. By the currying the same are torn open and are rendered more accessible to the washes. It is a fact that in the case of well kept cattle, the vermin are more easily removed than in the case of animals which are in a poor condition owing to bad food, want of care, etc. Therefore, according to the conditions of the case, the washing has to be performed once or twice.

Among the many preparations which are used for the extermination of skin parasites, such as essences, powders, benzine, petroleum, insect powder, creolin, etc., I can recommend, says a writer in the Pharmaceutische Zeitung, especially the last named if the treatment is carried out exactly as follows: The cows to be washed are thoroughly rubbed with a wisp of straw so that the scale, tangles, and dirt, are loosened. This done, curry diligently. Now the beasts are well washed with a warm 7 to 10 per cent. creolin solution, and subsequently brushed with a hard brush, always against the growth of the hair. A warm solution is preferable, to protect the cattle from taking cold. Draughts should also be avoided. Immediately after the washing, the stable should be thoroughly cleaned and scoured with creolin.

Another method of scouring cattle consists in mixing ordinary soft soap with creolin (strength 10 per cent.) lathering the animals with this, and washing off after a while with warm water.

For the extermination of parasites is always well suited tobacco leaves in the form of a strong extract or, better, as follows: Extract by boiling tobacco leaves 800 in 8 liters of hot water about three-quarters of an hour, remove the leaves, and after cooling, add Spir. Saponat. 500, and Spir. denaturat. 300.

The use of this liquid is the same as stated for the creolin wash. Especially for horse lice, a salve consisting of Ungt. Hydrarg. ciner. 200 Ol. animal. foltid. 300, and Sapo virid. 350 is employed with good success. The horses are rubbed with this salve and tied close to the halter, so that they cannot lick themselves. Afterward wash off with warm water or preferably with weak soap lye. I would, however, recommend the former methods with creolin or tobacco in such cases where the vermin are very plentiful, as they are more thorough, and horse lice are known to possess a tougher life than their relatives.

Somewhat more laborious for the layman is the employment of washing powder, which, if profusely used, is productive of good results, but in my opinion is not so energetic in its action as the first mentioned method. As good washing powders for cattle, etc., I would recommend the following: I. Sem. Sabadill. 125. Lign. Quassiae pulv. 250, Asafoetid. pulv. 25, Ol. Animal. foetid. 10. M. f. pulv.—S. The powder is boiled about one-half hour in 8 liters of weak vinegar, and subsequently made to acquire its original weight. II. Sem. Staphid. agr., Sem. Sabadill. Sem. Colocynthid. aa 120, Sapon. pulv. 400. M. f. pulv.—S. This powder is boiled for one-half hour in 20 liters of water to which 1 liter of vinegar was added, the loss in boiling is replaced with water, and afterward two tablespoonfuls of pine oil are added.

The veterinary surgeons besides employ arsenic and mercurous oxide in the wash. I believe, however, that the place of these strongly acting materials can be taken by creolin. Though not absolutely necessary, it is advisable to sprinkle the animals after the wash with insect powder or one of the following powders: I. Pulv. Pyrethe. 200, Sacch. lactis 100, Boracis 40. II. Lign. Quassiae pulv. 100, Sem. Colocynthid. 20, Boracis 50, Sacch. lactis. pulv. 40, Flor. chrysanthem. pulv. 200.

The Seifensieder Zeitung gives the following recipe for a soap for the same purpose: Melt cocoa oil 5 kilogrammes, and beef tallow, 5 kilogrammes; let cool to 25° C., and add with constant stirring; crude carbolic acid (100 per cent.) 1 kilogramme, ammonium carbonate (hartshorn salt) coarsely powdered 0·5 kilogramme, soda lye (28° B6.) 4·5 kilogrammes, and as soon as the mixture is uniform, 1 kilogramme of water.

Stir until the different parts of the mixture can no longer be recognized, and place as quickly as possible in wooden boxes lined with wet parchment paper, which are then covered up. All loss of time should be avoided, because the addition of water immediately causes formation of soap with spontaneous calefaction, whereby the soap becomes hard. Leave the boxes stand in the warm for three days, then cut the ready soap into pieces of equal size, let dry in the air and wrap up in tin foil.

This soap is excellent for washing animals to remove parasites, and is also adapted for disinfecting toilets.

SELECTED FORMULÆ.

Egg Lemonade.—

1. Break one egg in a soda glass, add 1¼ ounces of lemon sirup, a drachm of lemon juice and a little shaved ice; then draw carbonated water to fill the glass, stirring well.

2. Shaved ice ½ tumblerful.
Powdered sugar 4 tablespoonfuls.
Juice of one lemon
Yolk of one egg.

Shake well, and add carbonated water to fill the glass.

Orange Cream.—

Shaved ice	½ tumblerful.
One egg.	
Vanilla sirup	1 ounce.
Orange sirup	1 "
Ice cream	1 tablespoonful.

Fill the glass nearly full of cream, shake well, and add a little soda water.

Banana Sirup.—

Cut the fruit in slices and place them in a jar; sprinkle with sugar and cover the jar, which is then enveloped in straw and placed in cold water and the latter is heated to the boiling point. The jar is then removed, allowed to cool, and the juice is poured into bottles.

Banana Cream.—

Shaved ice	½ tumblerful.
Banana sirup	2 ounces.
Cream or milk	8 "

Shake well, add a few pieces of banana, and fill with soda water.

May Bells Perfume.—

Extract of jasmine	3,000 grammes.
Extract of violet	5,000 "
Extract of rose	1,000 "
Extract of cassie	1,000 "
Extract of orange flowers	1,000 "
Oil of linaloe	1 "
Oil of bergamot	1 "
Oil of coriander	1 "
Oil of mace	2 "
Oil of ylang-ylang	1 "
Alcohol	25 "

White Clover Perfume.—

Vanillin	20 grammes.
Heliotropin	20 "
Coumarin	20 "
Tincture of storax	½ ounce.
Tincture of civet	½ "
Tincture of orris	1 "
Oil of rose	1 drachm.
Oil of bergamot	1 "
Oil of neroli	1½ "
Extract of tuberose	4 ounces.
Extract of jasmine	8 "
Oil of cloves	5 minims.
Oil of bitter almonds	5 "
Terpineol	1 drachm.
Alcohol	8 ounces.
Glycerin	1 drachm.

Wood Violet Perfume.—

Extract of violet	800 grammes.
Extract of rose	1,100 "
Tincture of orris (1:50)	100 "
Oil of bitter almond	3 drops.

Bath Powder.—

Starch	24 ounces.
Sodium bicarbonate	40 "
Tartaric acid	36 "
Oil of bergamot	6 drachms.
Oil of lemon	1 "
Oil of lavender	1 "
Oil of pimento	30 minims.
Oil of linaloe	30 "
Heliotropin	30 grammes.

Cement for Glass and Porcelain.—Take one ounce of Russian isinglass, cut in small pieces, and bruise well; then add 6 ounces of warm water, and leave it in a warm place from thirty-four to forty-eight hours. Evaporate the resulting solution to about 3 ounces. Next dissolve ½ ounce of mastic in 4 ounces of alcohol, and add the mastic solution to the isinglass in small quantities at a time, continuing the heat and stirring well. While still hot strain the liquid through muslin.

Patchouli Bouquet.—

Oil of patchouli	½ drachm.
Oil of rhodium	15 drops.
Oil of rose geranium	30 "
Oil of citronella	20 "
Oil of orange	15 "
Oil of bergamot	1 drachm.
Oil of nutmeg	6 drops.
Oil of bitter almond	2 "
Oil of caraway	2 "
Benzoic acid	½ drachm.
Deodorized alcohol	18 ounces.

Lavender Water.—

Oil of lavender	2 drachms.
Alcohol	1 pint.
Rose water	6 ounces.
Magnesium carbonate	½ "

Rub the oil with the magnesium carbonate; add the alcohol and rose water, and filter through paper.

Grafting Wax.—T. Tidmarsh recommends in The Gardeners' Chronicle, the following mixture as a grafting wax:

Beeswax	1 part.
Rosin	3 "

Melt together. For use, remelt in a glue pot, the water jacket of which will retain it in a workable consistency for a considerable time, and also prevent it from being overheated to a point dangerous to the scions. For hot climates, the proportion of rosin should be increased to 4 to 1 of wax.

To Remove Rust from Iron.—Apply turpentine or kerosene oil, and after letting it stand over night clean with finest emery cloth.—Druggists' Circular.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

England, Germany, and the United States in the World's Markets.—Of the $18,000,000,000 worth of commerce done by all nations, England's share is 18·3 per cent., Germany's 10·8 per cent., and 9·7 per cent. falls to the United States.

Germany has built up her foreign commerce at England's expense; and the United States, which is just entering the field, is building up a great foreign trade at the expense of both.

In Australia, in Africa, in South America, and in China the commercial representatives of each nation are fencing for vantage ground upon which to build safe markets for home industries.

Formerly, English buyers bought manufactured goods in Germany at ridiculously cheap prices. These goods were forwarded to great merchant houses in London to be resold in foreign markets. To-day, these same goods for the most part are shipped from the district of manufacture direct to the buyer in foreign countries. The middleman's profits now go to enrich the German manufacturer and laborer.

The following causes have contributed to Germany's success in competition with England.

First. German manufactured goods are cheaper and in some cases better.

Second. German merchants adapt themselves entirely to the wants of their customers. Industrial commissions have been sent out to South America, Mexico, China, Japan, South Africa, etc., to study and report upon the conditions and needs of the people in those countries.

Third. The German traveling men have a better technical knowledge of their branches and are familiar with more languages than agents of other countries. They are active, resourceful, and gifted with tact, three essential things in selling goods in a foreign country.

If we ever hope to obtain the first place commercially, we must watch and, to a certain extent, adopt the weapons of our rivals, viz.: Technical schools, trained traveling men, permanent and able consular officers who are keenly alive to all commercial interests, a merchant marine large enough to carry three-fourths of our exports, and sound money.—John F. Winter, Consul at Annaberg.

Testing Firearms in Liege.—The government testing of all firearms manufactured in Belgium is of more importance than is generally recognized at first thought, for it does away almost entirely with accidents caused by the bursting of guns in the hands of sportsmen, and prevents manufacturers imposing dangerous and worthless guns on the public. The test of the cheap double-barrel breach-loading shotgun manufactured in Belgium and sold in the United States at from $10 to $12 is just as thorough and complete as the one that sells for $150, and the same is true of all the guns made in this country.

Liege being the leading firearms-manufacturing city of the world, it has the most extensive as well as the most complete proving station. The government has provided very strict rules and regulations to govern it, and the director, Mr. Jules Polain—to whom I am indebted for much of the information given in this report—is very jealous of its reputation.

The law of the land makes it a crime to sell, offer for sale, or to be found in possession of a gun, pistol, or any kind of firearm not bearing the proper government test marks, or a gun of a different caliber than that stamped on the barrel; the fine is not less than 50 francs ($9.65) nor more than 100 francs ($19.30), and the arm in question is confiscated.

It is also a crime severely punishable for anyone to put any testing marks on firearms, or even to mark the caliber, to add the words "choke bored," or anything of a similar character.

Single-barrel muzzle-loading shotguns are tested but once, while a double-barrel is tested twice. A single-barrel breech-loading shotgun is tested twice, while a double-barrel is tested three times. The guns having more than one test have the barrels tested before they are fastened together, and again when breechblock is finished. In all cases, at least double the usual charge of powder is used, and that of an extra-fine quality, which is carefully tested three times each week; and one-third more shot is used than ordinarily.

The loss by testing varies from 1 to five per cent.; the largest percentage of loss is in the higher priced and lighter guns. The same quality of steel is used for all barrels, but the difference comes in the workmanship and weight.

The cost of testing is paid by the manufacturer, and is 1 franc (19·3 cents) for the three tests.

To give an idea of the growth of the firearms industry in Liege, I note, says Alfred A. Winslow, Consul at Liege, the total number of tests made at the proving station for the past three years: In 1897, there were 1,712,800; in 1898, 1,968,708; and in 1899, 2,238,326; showing in two years an increase of 525,526 tests.

Medical Examination in Turkish Custom Houses.—The secretary of legation at Constantinople, Mr. Griscom, under date of April 28, 1900, transmits translation of the new rules concerning medical examination in the custom houses of the Ottoman Empire, which have been summarized as follows:

Chemical preparations, drugs, foodstuffs, spirits, soaps, painted toys, etc., after the usual customs examination and registration on their arrival, are submitted to a free medical inspection by a board consisting of five chemists and two doctors. If the entry of the goods is permitted, the chemists place their seals at the foot of the register, and the samples are returned to the custom house. Goods found to be adulterated, sour, or harmful to health are noted in the custom house register, the samples are kept for ten days, then sealed in the presence of the owner, with the date of the analysis, and returned to the place of origin or sent to a foreign country at the option of the owner, who must furnish a guaranty. Owners may, within eight days, demand a second analysis of the Imperial School of Medicine, the fees for which must be paid in advance. The second analysis must be made within fifteen days. If, after the second analysis, the goods are admitted, the fees will be returned. When there are several samples of similar merchandise, fees will be charged on only one sample. The importation of medicines the composition of which is not known and which do not conform with the French "codex" adopted by the Imperial Government is prohibited, unless, having been accepted by an official academy, the samples are accompanied by the formula and the diploma of admission. The documents must be visaed by an Ottoman consul, then the authorization of the School of Medicine may be obtained.

Cocaine and its compositions, sulphonal, Dr. Koch's antituberculosis serum, Gneiss' picrotoxin, and any specialties prepared with hasheesh and of which the import is prohibited are returned under guaranty. The entry of chlorate of potash, chlorate of soda, nitrate of soda, nitrate of potash, picrates, nitro-glycerine, and guncotton are prohibited, except in quantities necessary in medicine, and these articles are confiscated. The amount will be decided by the School of Medicine. Quantities in the various arts and trades will be fixed by the proper authorities.

The entry of impure or mixed oils, unless colored for use in manufacturing purposes, is prohibited.

Flour not containing a minimum of 9 per cent. gluten or an elasticity of at least 25° cannot be imported. The import of colored, adulterated, or artificial coffee and tea is prohibited. Dry provisions, liquids, sugars, colored or adulterated, will be returned to their place of origin. Alcoholic liquors mixed with salicic acid or colored are prohibited. Soaps must not contain more than one-half of 1 per cent. of caustic soda, and be free from silicate of soda, chalk, talc, etc. The entry of toys, paper, or envelopes used for the packing of provisions is prohibited, if they are colored with poisonous substances.

Resources of Siberia.—An important conference was held in Lyons recently on the resources of Siberia and its possible competition with cereal-producing countries, says Consul John C. Covert of Lyons. The principal speaker was Mr. Emile du Marais, a civil engineer who has passed many years in Russia and is a member of the Russian section of the French bureau of foreign commerce. He said that 200,000 farmers arrive in Siberia annually, the government providing them with free transportation and giving each family the free use of 15 hectares (37⅛ acres) of land for a stated time. The population of Siberia is now 8,000,000. Making a computation upon the basis of the population of Russia in Europe, Siberia is capable of sustaining a population of 80,000,000. The annual production of cereals in Siberia is 20,000,000 metric quintals (2,000,000 metric tons), 6,000,000 to 8,000,000 quintals of which are exported. The country can produce 10,000,000 tons annually, from 4,000,000 to 5,000,000 tons of which are subject to exportation. Siberia now exports butter to Denmark. It is estimated that she can export annually 80,000,000 francs' ($15,440,000) worth of butter, wool, leather, dried and preserved meats; and fish and tallow may figure conspicuously in her exports in the near future.

A movement is now in progress in the direction of forest preservation, the destruction having caused a scarcity of furs, blue fox and zibelines.

Siberia produces one-tenth of the world's yield of gold, and but few of the mines have been worked, on account of the climate. The immense coal deposits have hardly been touched. One mine, with six beds, contains as much coal as all the deposits in England. The lack of transportation facilities alone has prevented it from being worked.

The Trans-Siberian Railroad, from an economic and a political standpoint, is the greatest work of this century. It gives Russia a superior standing in Pekin. It now touches the Amur; in three years it will reach Port Arthur, making the distance but thirteen or fourteen days from Moscow to Pekin.

There is annually an excess of 1,500,000 births over deaths in Russia, and Siberia is the outlet for this overflow. The black lands of Siberia form an area of not less than 50,000,000 hectares (133,550,000 acres), but high freight rates are an obstacle to the arrival of their cereal products in France. The average freight rate on the Trans-Siberian is three-tenths of a cent per ton per kilometer (about five-eighths of a mile). In France, the minimum rate is four-fifths of a cent per ton per kilometer.

French capitalists, added Mr. Marais, have invested a great deal of money in Russian railroads and various industries in that country. Since the date of these investments, the heavy imports from Russia and the meager exports from France to that country have been a cause of complaint among French capitalists. In return for something like $700,000,000 invested in Russia, they see Russian purchases made in the United States, England, and Germany, while France receives Russian products as dividends for her capital. Some remonstrances have been made to Russia, but the only answer has been a suggestion that France should reduce her heavy protective tariff on Russia's wheat.

Increase of United States Trade in Turkey.—The freight brought to Constantinople and other Levantine ports by the steamship "Brand," the last steamer of the Barber direct line, indicates a gratifying increase in amount and variety of American products entering these ports, says Consul-General John M. Dickinson, of Constantinople. The "Brand" has just started on her return voyage to the United States, having delivered about 2,000 tons of railroad material at Alexandria, intended for the railroad up the Nile, and about 800 tons of other products at this port and Smyrna.

The American goods and products delivered at Smyrna, Constantinople, and Salonica include pumps, phonographic goods (nearly 4,550 pounds), leather, rubber boots and shoes, large variety of hardware, cotton cloth, tinware, lamp goods, wooden ware, milling machinery, cotton belting, mowing machines, chairs, and other furniture, clocks, iron bedsteads, one Mosler safe, paints, lard and oleo, domestics, flour, and nearly 6,000 kegs of wire nails.

Since the establishment of the direct line and the consequent reduction in freights, wire nails and a few other articles of American manufacture appear to have taken possession of the Levantine markets. In the opinion of good judges, many other staple articles will be equally popular when once fairly introduced. For the first time in the history of Constantinople, as I am informed, some of the leading stores, notably the Bon Marché and Hayden Brothers, have given orders for a line of American boots and shoes. They are so far superior to those of European manufacture that importers have every confidence in their extensive sale.

The captain of the "Brand" reports that nearly 200,000 tons of railroad material will be used on the Nile Railway during the coming season, and that the bulk of the orders will probably be given to American manufacturers.

Another steamer of the Barber direct line, the "Stalheim," is expected at this port in a few days. She brought a cargo of case oil to Athens, is now taking part of a load of chrome ore at Ismid, and will stop at Constantinople and other Mediterranean ports on her way to the United States.

Patents and Trade Marks in Korea.*—Korea has no patent laws or laws covering trade marks or copyrights. There is no present prospect of legislation covering these subjects. Up to date, I know of no infringement on the part of natives of Korea of patents or trade marks, though Japanese merchants in Korea have given considerable trouble to an American company by importing Russian and Sumatran oil in American kerosene tins, and selling it as the genuine article at a reduced price. Considerable effort was made to have this practice abolished; but the results were not satisfactory, and the company suffering from the practice had to take measures for informing the native merchants of the fraud, and so enabling them to guard against it.

The Koreans are not a manufacturing people, and there is little danger that they will imitate foreign goods or marks, as seems to be the case in the adjoining countries—China and Japan. Protection in these latter countries would probably furnish all the protection required in Korea, as most of Korea's imports come therefrom.—Horace N. Allen, Consul-General at Seoul.

Electric Railways in Gothenburg.—Consul Bergh writes from Gothenburg, April 12, 1900:

Referring to my reports of September 26, 1898, and April 6, 1899,† regarding the electric street railways in Gothenburg, I have to inform the Department that the city council yesterday decided that the city itself shall build and run the new electric street railways. In all probability, the proposed lines will be extended considerably, and more rolling stock and other material will be needed than at first estimated. American firms intending to compete with Swedish and German manufacturers should address communications to Figge Blidberg, Esq., engineer, manager of the city tramways, Gothenburg.

Opening for Coal in Trieste.—The Bureau of Foreign Commerce has received a letter from a firm in Trieste (Fr. Buzzi d'J), which says:

"Would you be kind enough to favor us with the addresses of the largest and most responsible coal collieries in Virginia, Pennsylvania, Alabama, and Ohio. We are in possession of several names of coal-export firms in New York and Baltimore, but steamship companies and customers here prefer to deal with the collieries direct."

Not wishing to discriminate between coal companies, the Bureau of Foreign Commerce takes this method of bringing the matter to the attention of those interested.

Telephone Tariff in Wurttemburg.—The Department has received from Consul-General Guenther, of Frankfort (under date of March 21, 1900), and Consul Hughes, of Coburg (under date of March 22), reports to the effect that the annual charge for telephones in Wurttemberg has been reduced to 80 marks ($19.04). The cost for a five minutes' talk over the local circuit is 5 pfennigs (1·19 cents); for a distance not exceeding 15 kilometers (9⅜ miles), 10 pfennigs (2·38 cents); up to 50 kilometers (31¼ miles), 20 pfennigs (4·76 cents); for longer distances, 50 pfennigs (11·9 cents).

Life-Insurance Companies in Russia.—Under date of April 14, 1900, Consul Smith writes from Moscow:

The capital invested by insurance companies in Russia amounts to 418,000,000 rubles ($209,000,000). The number of persons insured in 1899 was 21,114, the insurance amounting to 71,000,000 rubles ($35,500,000). Of the above amount, 41,840,710 rubles ($20,920,355) was received by American insurance companies; the balance by Russian.

The Russian people, adds Mr. Smith, are only beginning to realize the advantages of life insurance.

Bids for Printing in Paraguay; Bubonic Plague.—Consul Ruffin writes from Asuncion, April 6, 1900, that bids will soon be requested for printing 3,000,000 or 4,000,000 postage stamps of different colors. Interested parties should address the postmaster-general, Señor Angel Peña.

Paraguay has been officially declared free of the bubonic plague.

German Sugar Reports.—Vice-Consul Murphy sends from Magdeburg copies of Cohr & Ammé's weekly sugar reports, showing arrivals, shipments, and stock in Hamburgh. These reports are filed in the Bureau of Foreign Commerce, where they may be consulted by interested parties.

* This report was made in answer to inquiries by a New York firm, which has received a copy.

† Consular Reports Nos. 219 and 226; Advance Sheets Nos. 254 and 414.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 741. May 28.—Industrial Conditions in Scotland—Scottish Working Girls Discarding Cotton Dresses for Woolen—Germany's Capital Abroad—German vs. American Textiles—*Medical Examination in Turkish Custom Houses—American Shoes in French Switzerland.

No. 742. May 29.—Waste Products of Cotton Mills.

No. 743. May 31.—*Resources of Siberia—*Increase of United States Trade in Turkey—*Soap Trust in Germany—*German Sugar Reports—*Bids for printing in Paraguay; Bubonic Plague—*Uruguayan Trade in 1899.

No. 744. June 1.—Commerce of China in 1899.

No. 745. June 2.—British Exports of earthenware to the United States—*England, Germany, and the United States in the World's Markets—Consumption Tax in Madagascar—Lighthouse Dues at Puerto Cabello—*Newspapers in Russia—*Life Insurance Companies in Russia—*Land Grant in Brazil.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

THE KINETIC THEORY OF PLANETARY ATMOSPHERES.*

By G. H. BRYAN, Sc.D., F.R.S.

THE application of the kinetic theory to the atmospheres of planets dates from the paper of Waterston, who gave an investigation based on the then only possible assumption of equal velocities for all molecules, an assumption since known as Clausius' law. Of later papers reference is due in especial to Dr. Johnstone Stoney's memoir "Of Atmospheres on Planets and Satellites" (Trans. R. Dublin Soc.), in which the test of permanence of a gas in the atmosphere of a planet is made to depend on the ratio of its velocity of mean square to that relative velocity which would enable a suitably projected body to escape from the planet's attraction. If it be admitted, as Dr. Stoney assumes, that helium cannot exist in our atmosphere, it follows that vapor of water cannot exist on Mars.

The author's object has been to investigate the logical conclusions obtained by applying the Boltzmann Maxwell distribution to the atmospheres of planets. In 1893 calculations were made, having special reference to the absence of atmosphere from the moon, but these took no account of axial rotation. When this cause is taken into account, the distribution of co-ordinates and relative velocities of the molecules is found to be the same as if the planet were at rest, and "centrifugal force" applied to the system. The surfaces of equal density are of the forms originally investigated by Edward Roche, of Montpellier, and they cease to be closed surfaces when passing to the outside of the point on the equatorial plane where centrifugal force just balances the planet's attraction. Calling the surface through this point the "critical surface," the density of molecular distribution over this surface must be very small to ensure permanence. The ratio of the density at the planet's surface to the density at the critical surface has been called the "critical density ratio," and the author calculates its logarithm for particular gases at different temperatures on the various planets. The use of this logarithm has the advantage that the calculation can at once be extended to any gas at any temperature.

The high value obtained in the case of helium considered in reference to the earth, appears to afford abundant proof that if helium existed in our atmosphere it would possess a very high degree of permanence at ordinary temperatures. To test this point further, a calculation is made of the total rate at which molecules would flow across the critical surface, this rate being regarded as a superior limit to the rate at which the planet would lose its atmosphere, since it takes no account of molecules which describe free paths beyond the limit and fall back again. To further exhibit the results in a tangible form, the rate of flow is estimated by the number of years in which the total amount of gas escaping across the critical surface would be equal to the amount of the gas in a layer covering the surface of the planet to the depth of 1 cm. This measure is independent of the actual quantity of the gas under consideration existing in the atmosphere, since, if this quantity be increased, the rate of flow across the critical surface and the amount of gas present in the surface layer 1 cm. thick will be increased in the same proportion.

If a gas of molecular weight 2, such as helium, be supposed to exist in the earth's atmosphere, the loss in question would occupy $3{\cdot}5 \times 10^{26}$ years at $-73°$ C., 3×10^{19} years at 27° C., $8{\cdot}4 \times 10^{10}$ years at 127° C., 6×10^{5} years at 227° C., and 223 years at 327° C.

If we halve the absolute temperatures we have the conditions applicable to hydrogen, the losses in question therefore taking place in $8{\cdot}4 \times 10^{10}$ years at $-73°$ C., 6×10^{5} years at $-23°$ C., and 223 years at 27° C.

For water vapor on Mars, the corresponding results are $1{\cdot}2 \times 10^{22}$ years at $-73°$, $1{\cdot}9 \times 10^{16}$ years at 27°, $2{\cdot}4 \times 10^{9}$ years at 127°, $4{\cdot}3 \times 10^{4}$ years at 227°, and 106 years at 327°.

These figures indicate that helium cannot practically escape from our atmosphere at existing temperatures, nor can vapor of water escape from the atmosphere of Mars. A leakage may and undoubtedly does take place which may appear considerable when estimated by the number of actual molecules escaping, but it is wholly inappreciable relative to the mass of gas left behind.

At a future time I propose to examine the corresponding results, based on the hypothesis that the atmosphere of a planet is distributed according to the adiabatic instead of the isothermal law.

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Land Grant in Brazil.—Consul Kenneday, of Para, April 15, 1900, writes:

A Brazilian citizen—Mr. Manoel Floriano Correa de Britto—has obtained a most valuable concession of lands near Manaos. I forward herewith a copy, in Portuguese, of the terms of agreement. The property consists of several thousand acres of rubber and cocoa land, including immense belts situated on the banks of the Rio Negro, Rio Japura, and Rio Branco.

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* Abstract of a paper read before the Royal Society, April 5, 1900.—From The Chemical News.

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RELATION OF HEIGHT, WEIGHT AND STRENGTH TO THE CEPHALIC INDEX.*

IN a number of Science Progress (October, 1898), Dr. John Beddoe had the following to say of the dolichocephalic and brachycephalic types of races: "The tall, blond, long-headed people of the north of Europe are the salt of the earth—the stirring, active, ambitious, independent, courageous, locomotive element of mankind. He dares everything, and his audacity insures success. He fights for fighting's sake; every land is his; the whole globe is his country. His intelligence varies from stupidity to genius. Progress is his greatest need.

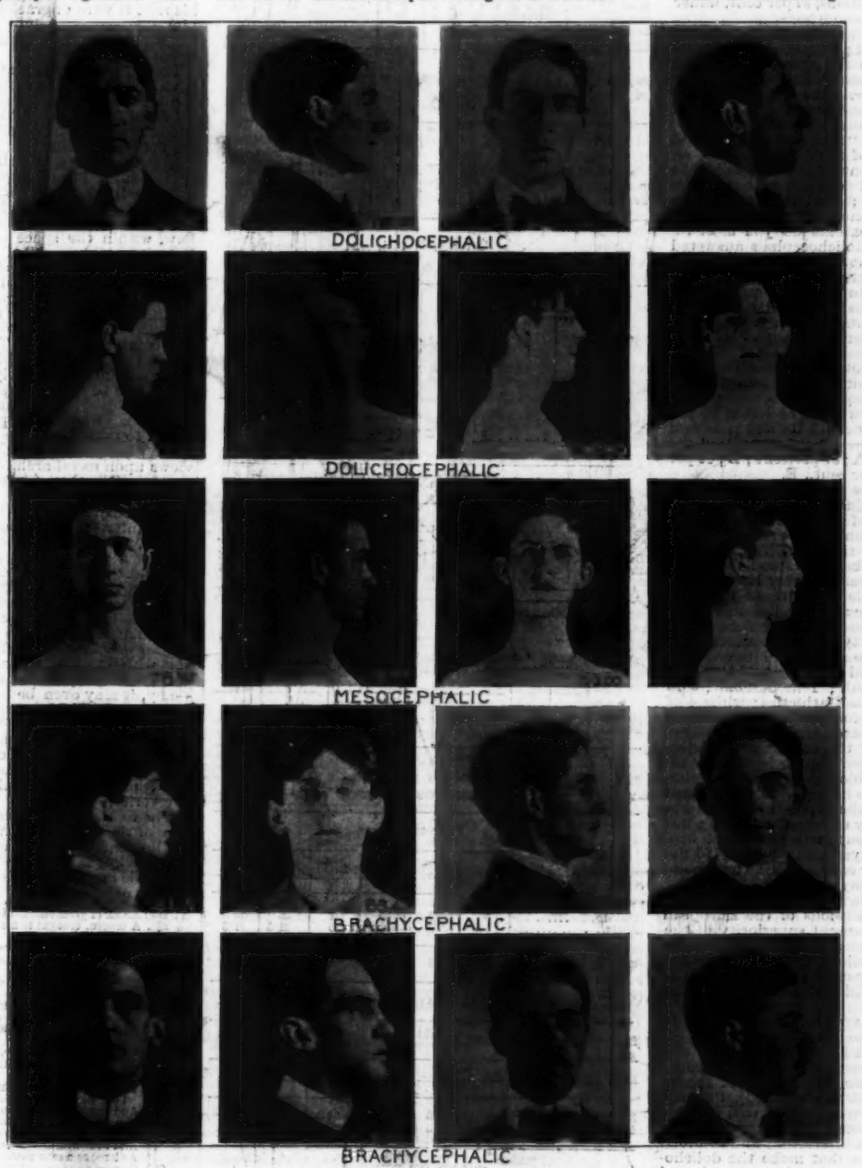
The other type of race with which we have most to do is the brachycephalic, or short-headed Alpine. In this the stature is short, the head is round or trapezoidal, flattened behind, the coloration brown or dark. The brachycephal is frugal, laborious, or at least economical, remarkably prudent, and though not cowardly, yet not warlike. His intelligence is usually mediocre, and he works out patiently his limited ideals. He is the slave of tradition, and what is called common sense. He distrusts progress and adores uniformity. According to Dr. Ammon, the dolichocephalic type abounds in cities. He has more than his proportionate share of wealth and social and political distinction. He stands high in the schools of learning. Among thirty members of a scientific society, Ammon found great length of head in every case. Athletes, too, are generally dolichocephalic."

The conclusion of many European anthropologists in regard to the mental and physical characteristics of these two racial types has occasioned so much popular, as well as scientific, interest, that I will try to show how far these deductions are applicable here in America. For this purpose I took the record cards of 1,100 Harvard students who had been recently examined at that university, and had them sorted into groups according to their cephalic indices. Those students who had an index of 75 or less were classed as dolichocephalic. In this group there were 116. Those who had an index between 75 and 77·77 were classed as sub-dolichocephalic, in which group there were 284. Those who had an index between 77·78 and 80 were classed as mesocephalic. In this group there were 331. Those who had an index between 80·01 and 83·33 were classed as sub-brachycephalic. The number was 261. Those who had an index of 83·33 and over were classed as brachycephalic. Their number was 108.

These different groups were then arranged according to their mean or medium height. By referring to Table 1, the distribution of the several groups according to height is perfectly apparent. The mean for the dolichocephalic type is 175·5 centimeters, which is 5 feet 9 inches and a fraction; and the other groups arrange themselves in order in a regular regressive series down to the brachycephalic group, in which the mean height is 171·5 centimeters, or about 5 feet 7½ inches.

The same is true in regard to the weight, the dolichocephalic group showing a mean weight of 63 kilogrammes, about 138·91 pounds; and the mesocephalic, sub-dolichocephalic and sub-brachycephalic groups a mean weight of 61·5 kilogrammes, or 135·60 pounds.

The height and weight of an individual may usually be regarded as a fair indication of his potential strength; but in order to ascertain the real strength, a test has been adopted by many of the American colleges which takes nothing for granted. The strength test which most of our students are put through is as follows:



TYPES OF HEAD FORMS.

Ascertain the number of kilogrammes lifted with the back and legs straight and the number of kilogrammes lifted with the legs bent. Add this amount to the strength of the grip of the right and left hands, expiratory power as tested by the manometer, and one-tenth of the weight in kilogrammes, multiplied by the number of times that the person can raise his weight by dipping between the parallel bars and pulling his weight up to his chin on a horizontal bar, giving a very good all-round test. The total amount is termed the total strength; and all students at Harvard, desiring to enter as competitors in tests of strength are required to reach a certain mark as evidence of their ability to enter this contest. Candidates for the university teams are expected to make a total strength test of 700 points. Candidates for the class crews and foot-ball teams, 600 points. Candidates for the class ball nines, lacrosse teams, track and field events and the lighter forms of athletics, 500 points. After twenty years of trial, this test has been found to afford a practical and ready method of weeding out weak men and giving some knowledge of a man's functional power.

Grouping our different racial types according to the record of these tests, we found the following results: The mean strength test of the dolichocephalic class was 575 points, and the mean of all the other classes was about 550 points. I say about 550 points, because in tabulating the clerks were instructed to make their cards group to the nearest 25 points, in order to shorten the amount of labor necessary to complete the work. This method brings into the 550 group all numbers ranging between 537 and 562. This accounts for the sameness of the totals in the several classes. Had the divisions been made finer, I feel confident that the same regression would have been brought out in the strength tests as was shown in the height and weight. This tendency shows itself in the grouping of the extremes. Over 5 per cent. of the dolichocephalic class surpassed a strength test of 800 points, while only 5 per cent. of the brachycephalic class surpassed 700 points, an amount which was exceeded by 18 per cent. of the dolichocephalic class.

In looking at the nationality represented by the grandparents of the different classes (and that was about as far as we could go), it was found that the dolichocephals claimed that 81 per cent. of their grandparents were Americans, while the sub-dolichocephals, mesocephals, sub-brachycephals and brachycephals maintained that 77 per cent., 67 per cent., 60 per cent. and 57 per cent., respectively, of their grandparents were born in this country. You see there, again, the regular regression toward the more foreign type.

The most numerous of the foreign ancestors were from England, Germany, Ireland and Scotland. The combinations of English-American, Scotch-American, Scotch-Irish, etc., were quite numerous as to the variety, as shown in Table No. 2, but quite few numerically, many being less than 1 per cent. It will be observed that the number with American ancestry decrease regularly and the number with foreign ancestry increase proportionally as we recede from the dolichocephalic to the brachycephalic type. The tabulation of the nativity of these two types by States brought out the fact that 54·4 per cent. of the dolichocephals were born in Massachusetts, 8 per cent. in New York, 3·5 per cent. in Ohio, 5·3 per cent. in Rhode Island and 3·5 per cent. in foreign countries; while 36 per cent. of the brachycephals were born in Massachusetts, 9·5 per cent. in New York, 6·6 per cent. in Pennsylvania, 6·6 per cent. in Illinois, 3·8 per cent. in Ohio, 1·5 per cent. in Rhode Island and 16·1 per cent. in foreign countries. The large percentage in both classes who were born in Massachusetts is due to the fact that nearly one-half of all the students of Harvard University are from that State. The natives of States numbering only 1 per cent. or less are not enumerated in the table.

In order to learn something of the nurture and social status of the two extreme types, the cards were grouped according to profession or occupation of father, city or country life, general health, college standing, athletic sports, etc., as shown in Table No. 4. The number of

* An address delivered December 28, 1899, at Yale University, by D. A. Sargent, M.D., Director of Hemenway Gymnasium, Harvard University, before Section H, Anthropology, of the American Association for the Advancement of Science at its winter meeting.

By the term cephalic index is meant the breadth of the head above the ears expressed in percentage of its length from forehead to back. Thus if the head were 6 inches wide and 8 inches long, the cephalic index would be 75. The formula for ascertaining it is

$$\frac{\text{(6 inches) Breadth of head} \times 100}{\text{(8 inches) Length of head}} = 75$$

different occupations represented was 52. Grouping them as far as possible into the four large classes, we find that 48 per cent. of the fathers of the dolichocephalic type represented the professional class, 34 per cent. the commercial, 7 per cent. the laboring and 3 per cent. the artisan class. Applying the same method of grouping to the brachycephals, it was found that 47 per cent. of their fathers were in the professional class, 37 per cent. in the commercial, 11 per cent. in the laboring and 3 per cent. in the artisan class.

A finer division of the professional and commercial classes into merchants, lawyers, physicians, clergymen, bankers, manufacturers, and retired men or gentlemen of leisure, represents the dolichocephals having 55 per cent. of their fathers, and the brachycephals 46 per cent. of theirs in what would probably be termed the higher and upper middle classes, in distinction from the lower middle and the so-called laboring classes.

When grouped according to natural advantages as represented by city or country life, it was found that 60 per cent. of the dolichocephals were born and bred in the city, and 40 per cent. in the country; whereas, 56 per cent. of the brachycephals were born and bred in the city and 44 per cent. in the country. In this connection, however, it should be stated that all cities under 10,000 inhabitants were claimed as country. Considering the more immediate environment as represented by the conditions attending one's occupation, as open air, muscular exercise, sedentary employment, etc., as being favorable or unfavorable to health, we find that the fathers of 50 per cent. of the dolichocephals worked under good conditions, 30 per cent. under fair and 12 per cent. under imperfect, or bad, conditions; while 56 per cent. of the fathers of the brachycephals worked under good conditions, 37 per cent. under fair, and 9 per cent. under bad conditions.

In answer to questions as to health, 95 per cent. of the dolichocephals replied good; 2·9 per cent., fair; 1·9 per cent., poor. In answer to the same question, 91 per cent. of the brachycephals replied, good; 4 per cent., fair; and 4 per cent., poor. The natural vigor of parents and their ability to stand the wear and tear of life may be inferred from the number of deaths.

In answer to the question, "Are your father and mother living?" 18 per cent. of the dolichocephals replied, "father dead;" 11 per cent., "mother dead." In answer to the same question 11 per cent. of the brachycephals replied, "father dead;" and 11 per cent. recorded the death of the mother. In answer to the question, "Which of your parents do you most resemble?" 39 per cent. of the dolichocephals answered "father," and 39 per cent., "mother;" while 3 per cent. answered "neither," and 18 per cent. were undecided, or failed to reply. In answer to the same question, 30 per cent. of the brachycephals replied, "father;" 42 per cent., "mother;" 4 per cent., "both;" 2 per cent., "neither;" and 21 per cent. were in doubt or failed to answer.

In order to get at the intellectual status of the two extremes types, the college rank list was appealed to. Six per cent. of the dolichocephals had received an average rank of A (that is, between 90 and 100); 30 per cent, B; 54 per cent., C; 9 per cent., D; and some had dropped out of college. Of the brachycephals, 10 per cent. had an average rank of A; 37 per cent., B; 44 per cent., C; 10 per cent., D; 1 per cent., E.

The physical resources of the two types may be inferred from their standing in athletics. The dolichocephals had 23 per cent. of their numbers on the college athletic teams; while only 21 per cent. of the brachycephals claimed this distinction. To get on the college athletic teams it must be understood that they have to undergo among themselves a very hard trial of competition; and it is considered quite an honor to get on a team. There may be a hundred men trying, and perhaps only ten will succeed. The special athletic abilities of those of the two types who succeeded in getting on various athletic teams may be inferred from the kind of sports they excelled in. Seven of the dolichocephals excelled in football; 1 in baseball; 6 in rowing, and 15 in field and track athletics; while 4 of the brachycephals excelled in football, 4 in baseball, 6 in rowing, and 8 in field and track athletics.

The racial characteristics of the two types as determined by color of hair and eyes may be judged by referring to Table No. 5. The blondness of the dolichocephalic type does not seem to be especially prominent over that of the brachycephalic type—both blondness and brunetteness being pretty evenly distributed; but a fact which is made prominent is the excess of brunettes over blonds in both types, there being 66 per cent. of the former and 34 per cent. of the latter among both dolichocephals and brachycephals.

How far the results of this investigation have tended to confirm or refute the conclusions of the European anthropologists as to the general superiority of the dolichocephalic over the brachycephalic type, I must leave to my hearers to determine. The facts brought out are very suggestive to my mind; and I regret the brief time at my disposal will not admit of further elaboration.

If we have in our midst a type of man superior in height, weight and strength to other types, it is an exceedingly interesting fact, and I cannot conceive of any grouping of men, unless you pick them out according to their height for some special purpose (as, for instance, our policemen are generally selected); I cannot think of any grouping that would bring out what so high an average as, for instance, in height, of 5 feet 9$\frac{1}{10}$ inches means. It is also both interesting and comfortable to note that the qualities that make the dolichocephalic type superior have endured the shock and strain of hundreds of years, and are, indeed, so persistent that in some instances they defy even bad nurture and poor environment. It is also encouraging to note that, if we include the sub-dolichocephals, this type, probably, predominates in all our higher institutions of learning.

That the brachycephalic type should prove superior in scholarship, and the dolichocephalic type superior in athletics, is perfectly consistent with Dr. Beddoe's conclusions that the latter has more intellectual force; although probably there would be some difference of opinion in regard to that matter. Scholarship as determined by college rank is more dependent upon youthful application and on industry than upon natural intelligence, or superior mental force and vigor. Athletic men frequently fail to take high rank in scholarship while in college because they give so much time and energy to other pursuits. Where these same men, however, enter upon the study of their profession or at once launch upon their lifework, their superior mental force and energy of character soon bring them to the front, and they gain positions of distinction and eminence. Whether the dolichocephalic or brachycephalic types are the best fitted to survive the conditions of our climate and civilization, of course, is another question. I should say that the type most likely to prevail would be neither the dolichocephalic nor the brachycephalic, but, in all probability, would be the mesocephalic; and that this type will come to us through a general and more widespread diffusion of races.

TABLE No. 1.

THE RELATION OF THE CEPHALIC INDEX TO THE HEIGHT, WEIGHT AND STRENGTH.

No.	Head Forms.	Index.	Mean Height.	Mean Weight.	Mean Strength.
116	Dolicho	75	175·5 (5-9)	63 (138·9)	515 375-900
460	Dolicho and Sub.	77·77	174	62	500 350-900
284	Sub-Dolicho.	75-77·77	173·5	62	500 350-715
331	Meso.	77·78-80·00	173	62	500 350-775
261	Sub-Brach.	80·01-83·33	173	62	500 350-750
374	Brach. and Sub.	80·01 +	172·5	61·5	500 350-750
108	Brach.	83·33	171·5 (5-7$\frac{1}{2}$)	61·5 (135·6)	500 350-700

TABLE No. 2.

PERCENTAGE OF NATIONALITIES REPRESENTED BY GRAND PARENTS.

	American.	English.	German.	Irish.	Scotch.	French.	E. and A.	S. and A.	I. and E.	S. and E.	S. and I.	W. and A.	F. and E.	S. and W.	G. and A.	G. and E.	I. and A.	Hebrew.	Dutch.	Swede.	Welsh.
Dolicho	31	..	1	5	5	..	24	24	3½	1	.	1	1	1	.	.	.	.	.	.	.
Sub-Dolicho.	77	2	4½	1	.	.	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.
Meso.	67	4	3½	4	4	.	.	5	2	.	2	1	.	.	.	.	.	1½	.	.	1
Sub-Brach.	90	4½	7	3	1½	.	5	3	1	.	1½	.	.	.	.	1½	2	2	.	1	.
Brach.	57	2½	10	6	.	.	.	4½	.	.	.	.	.	.	.	.	4½	.	14	.	1½

TABLE No. 3.

PERCENTAGE OF NATIVITY BY STATE.

	Mass.	N. Y.	Pa.	Ill.	O.	R. I.	Foreign
Dolicho.	54·4	8·0	3·5	2·0	3·5	5·3	3·5
Brach.	36·0	9·5	6·5	6·5	8·5	1·0	16·1

TABLE No. 4.

NURTURE AND SOCIAL STATUS.

	P.	C.	L.	A.	Merchant.	Lawyer.	Physician.	Clergyman.	Bank Clerk.	Manufacturer.	Retired.	Born and Bred. City	Born and Bred. Country.
Dolicho.	48	34	7	3	19	10	7	4	6	4	5	60%	40%
Brach.	47	37	11	3	18	8	3	6	5	6	..	56%	44%

	Environment			Health.			Dead.		Resemblee.				
	G.	F.	P.	G.	F.	P.	Fa.	Mo.	Fa.	Mo.	Bo.	N.	?
Dolicho.	50	30	12	95	3·9	1·9	14	11	39%	39%	....	3%	18%
Brach.	56	37	9	91	4	4	11	11	30%	42%	4%	2%	21%

	College Rank.					Athletic Sports.				
	A. 90-100	B. 80-90	C. 70-80	D 60-70	E. 50-60		F. B.	B. B.	Row.	Track
Dolicho.	6%	30%	54%	9%	....	23%	7	1	6	15
Brach.	10%	37%	44%	10%	1	21%	4	4	6	8

TABLE No. 5.

COLOR OF HAIR.

	Brunettes.			Blonde.		
	Black.	Dark Brown.	Brown.	Red.	Light Brown.	Fair.
Dolicho	5	22	39	4	25	5
Brach.	5·5	30	31	5	21·5	7·5
		66			34	

COLOR OF HAIR AND EYES.

Hair.	Brown	Dark.	Light Brown.	Brown	Dark Brown.	Brown.	Dark Brown.
Eyes.	Blue.	Brown.	Blue.	Brown	Blue.	Gray.	Gray.
Dolicho	93	13	9	7	7	7	5
Brach.	14	14	5	6	7	1	3

COLOR OF EYES.

Eyes.	Brown.	Blue.	Gray.
Dolicho.	32%	50%	22%
Brach.	40%	60%	9%

THE RAFT OF ULYSSES.

A STUDY IN ANCIENT CONSTRUCTION AND CARPENTRY.

By the late W. WATKISS LLOYD.

IN the account of the construction of the raft of Ulysses, upon which he was to leave the island of Calypso, we have an example of the artifice by which Homer blends details of such natural simplicity with his most marvelous incidents as to prevent our ever feeling that we are quite beyond the bounds of the possible, if not of the familiar. Poetic fiction here avails itself to admirable purpose of the same scheme which a prevaricating witness employs to give verisimilitude to his inventions—the apparently scrupulous introduction into the narrative of details which are quite unimportant relatively to the monstrous allegations which are alone matters of interest. So the poet by his specific minuteness on some matters blinds us to the coolness with which, as if on the strength of an established character for conscientiousness, he takes much more for granted. The difficulty which Ulysses experiences when his ship is first struck by lightning and then shattered is so truthfully described that it may easily not occur to the reader to inquire how it was that he could sustain life when he was swimming for nine days and nine nights before reaching the island of Calypso. Again, after the care the poet takes to explain how it was possible for Ulysses to construct his raft, it were ungracious and unreasonable to press him further as to how the hero could navigate it for seventeen days and nights without a wink of sleep.

This, therefore, is an artifice which, after warning, it is well to be on our guard against when attempting to recover the precise conception which the poet had in his mind of this navigable raft. He tells us minutely enough some of the details of the construction, but we are not free to infer that these are all, that he does not skip many others, and that the raft when complete as he imagined it, and expected it to be imagined, was not something much more complicated than the description quite accounts for. No explanation or apology is offered for calling upon us to accept the narrative how, within the space of four days and without exhaustion, Ulysses felled twenty trees, squared them, drilled them, bolted together a frame of the breadth of a merchant ship, and fitted his craft with mast, sails and rudder—four very good days' work indeed. After all this has been passed unchallenged, it is clear that we must not be too pressing for minute justification and complete details. The poet succeeds in conveying an impression that his description is complete, and when our object is simply to enjoy the poetry, we may consent to be hoodwinked. It is quite fair, however, after this desire has been indulged and due homage has been paid to the poetry, and it is quite worth while, to take the archæological point of view and inquire what particulars can really be made out as to his views upon naval architecture, on the technicalities of construction which he conceived to be applicable to a sea-going craft.

The construction of this raft was made the subject of an interesting and carefully studied paper by Mr. Warre, who is understood to have gained great position as a river coach of the young oarsmen of the Thames. His conception of a raft that has a chance of living at sea seems not entirely satisfactory. He gives an engraving to illustrate his interpretation of the poet's description, but his contrivance would surely be classed at Lloyd's much lower than the Eastern catamaran which, very candidly, he engraves for comparison with it. Rickety as it looks, this is assuredly a more seaworthy craft, and it is simpler of construction—nay, it may even be contended, is in more striking agreement with the terms of the Homeric specification. In this respect also Mr. Warre does not do himself, or his subject, or his readers justice; that while he scarcely provides a sufficiently literal translation of the passage which is the basis of his commentary, he does not consult the convenience of Etonians by quoting the verifying Greek.

The following is extracted from a complete translation of the "Odyssey," which follows the original line for line and word for word as closely as possible, and rendered, it is believed, in the nearest approach to the Homeric meter that the genius of the English language admits of:

V. 234. An ax of great size to his grasp very fitly adjusted she gave him,
235. A brasen, brought to a sharp edge on either side; to it attached was
A very beautiful olive wood handle, firmly fitted;
And after that gave him a well chipping adz; and she led the way onto
The island's extremity, where a growth of tall timber had sprung up,
Alder and poplar and pine tree, rising up to heaven,
240. Seasoned already and very dry, which would float for him lightly;
But when she had pointed out to him where was the growth of the tall trees,
Calypso, goddess divine, went back again to her dwelling.
But on he went felling the trunks, and his work for him rapidly speeded;
Twenty in all he brought down and with the brass tool trimmed them,
245. And very skillfully smoothed and brought by line to straightness.
Meantime Calypso, noble goddess, brought to him augers,
And then he drilled them all and matched them one to another;
And then with trenails and mortises bolted the raft together;
As large as a man shall round him the bottom frame of a vessel,
250 Of a broad merchantman—one who of carpentry has good knowledge—
Even so great was the size that Ulysses wrought for his broad raft;
And he put cross timbers in place and fitted to close-set uprights,
As he went on working; and lastly with lengthwise timbers completed,
And in it he wrought a mast and a sailyard fitted to it;
255. And for it moreover he made a rudder that he might steer it;
And he fenced it from end to end with work of twisted osiers,
For protection against the waves; and spread therein plentiful ballast.
And in the meantime Calypso, noble goddess, brought robes
For making sails, and these he also skillfully fashioned;
260. And in it belayed he the braces and halyards and in it the sheet-lines,
And on to the sea divine by aid of levers launched it.

It will be noticed that the tool-box of Calypso supplies no saw, and the adz is supposed to be sufficiently handy to enable Ulysses to shape and smooth the tree trunks so that they may be brought pretty close together. Mr. Warre observes that a contrast is in-

tended between the two tools by the notice with respect to the ax, that its sharp edge is produced by being ground on both sides. The metal of both tools is called chalkos. It is, of course, in strictness, not accurate to translate this as brass, or rather it would be a mistake to understand such a translation as implying an equivalent to the modern brass. Copper or bronze might seem more correct, but usage has established the word brass as the most conveniently and euphoniously representative word for a metal of which the properties as implied by the poet do not correspond with either pure copper or any bronze we are acquainted with. That the age of bronze swords was a reality is proved by the witness of a whole army of genuine weapons recovered from the ruins of time, but the examination of these does not explain how it was possible for axes formed of like metal to cut down oak trees, as in the preparation for the funeral pyre of Patroclus in the "Iliad," or even the dry but still sound spars which fall so readily under the strokes of Ulysses. However, the trunks being once felled, the next work of trimming them of their branches and bringing their sides to a smooth and level surface by aid of adz and line follows in order of course as specified. Then Calypso brings him augers—augers in the plural, therefore more than one, as if for different gages—and with these he bores his spars to receive the trenails which are distinctly specified. The trenails are long wooden pegs fitting tight into the opposite holes prepared for them, and so clamping two beams together. Dowels or soaks, as well explained by Mr. Warre, are shorter and thicker; they are thick for strength, and would be available to keep beams which are laid together side by side in their places against the force of water from below, but quite short in order not to weaken the timbers into which they are inserted.

In the line 348, "And then with trenails and joinings he bolted the raft together," trenails is an accurate and undoubted translation of the Greek gomphois. Mr. Warre translates harmoniesi by "dowels," but upon his own ill-supported responsibility. The translation "joints" or "joinings" is confirmed by a remarkable passage in which Herodotus describes the construction of Nile boats, a description otherwise illustrative of the raft which we are engaged upon. "They square timbers two cubits (3 feet) long, and lay them together brickwise (that is, so that one timber covers the joints of two beside it), fasten them with long frenails, and then cross them with other timbers." Then follows a clause which is of contested translation, as implying either "they caulk the joints with byblus," or "they strengthen the connections with lashings." Whichever is adopted, it is clear that harmonias is to be understood as joints or joinings more or less close. And so we may understand Homer to refer to the good carpentry of joints which, in conjunction with the trenails, gave solidity to the floor of the raft. It is quite inconsistent to suppose that Ulysses, working like a "man well skilled in carpentry," pinned together the floor of his raft entirely of timbers laid parallel. The joints which seconded the binding effect of the trenails were, of course, not parallel joints of timbers laid close together; these would be weak points which required strengthening. We must assume that they are the notched or mortised joints of cross timbers countersunk into the lengthwise timbers at either end of the raft. There was no necessity for these timbers to be brought quite close to each other; in fact, an interval gave opportunity for the further security of lashing to the transverse timbers. The word which Æschylus uses to describe the clenching of the rivets of the chain of Prometheus is the same which Homer applies to the knocking together of the mortises and trenails. Ulysses effected a firm joint by heavy blows bestowed not only on the trenails, but also upon the mass of the timbers which were to be brought up to and held in close contact at the points where the trenails were inserted.

The phrase of the comparison, "As large as a man shall round him the bottom frame of a vessel"—shall round or circumscribe it—involves an allusion to the floor of the raft being finished at either end with special adaptations. This, it will be seen, is the principle of construction of the catamaran, of which Mr. Warre gives an engraving.

His labors so far have formed a heavy and well compacted platform, which the poet compares in respect of size to the frame or horizontal plan of a merchant vessel. We may translate the word employed as "the floor" provided we do not understand it to mean the deck. The size seems extravagant, but that is the poet's business. The raft is more than once referred to before there is an end of it, as manifold bound—polydesmos, as if strengthened by lashing. So Æschylus describes the bridge of Xerxes over the Hellespont as a raft lashed together with flaxen ropes. Ulysses is found to have a supply of ropes for his rigging, and the poet probably assumes and intends us to assume, if we care to think about it, that he employed ropes in connecting or strengthening various parts of his construction. A mere combination of clamped horizontal beams even when strengthened by others crossing at right angles would certainly be crank enough, and nothing is said of any timbers laid obliquely athwart them to secure true stiffness. The construction, apart from such transverse beams, would break apart forthwith.

Lightly as the timber employed might float, an upper construction is required if the navigator is to keep even his feet out of water. Accordingly Ulysses next erects uprights or posts upon this platform very close together, and to these he attaches timbers which are called ikria, a word which enters into compounds denoting benches or yard arms, and thus manifestly to be interpreted here as transverse to the length of the raft. But it is still more to the purpose that the word occurs in the "Iliad" and "Odyssey" as the name of the half deck of the Homeric ship which afforded footing, and the limited extent of which is shown by the fact that it might be occupied by a sleeper without interfering with the places and action of the rowers. Scarcely, therefore, in such a case as the present, are we entitled to assume more of a deck than Ulysses required to lie down upon, or perhaps even for a somewhat elevated seat from which to steer and manage the sail. The extensive upper deck which Mr. Warre assumes, and at a height to allow a man to walk under it, exceeds all the requirements of the case, and is entirely unsupported by the implications of the text. Ulysses, we then read, finished up his work so far with long epegkenides, a word which by its derivation and in agreement with the epithet seems literally translatable by "stretchers." It seems most consistent to regard these as gunnels (gunwales), the recognized completions of a raft, timbers laid to form a ridge along the edges. He then, as some protection against the wash of the waves, carried round it a fence of wattled osiers, and, according to an ancient interpretation of the next phrase, favored by Mr. Warre, backed it up with bundles of brushwood. According to an alternative, also ancient interpretation, he put in a great deal of ballast. Mr. Warre affords the best illustration of the superiority of the scheme of the raft here advocated, as compared with his own, by his engraving of the Oriental sea-going catamaran.

The rest of the bold navigator's arrangements explain themselves. But having brought the hero so far onward with his work, the least we can do is to see him off on his voyage:

> The fourth day it was, and by that had all been entirely completed,
> And on the fifth Calypso divine set him forth from the island,
> When she had fully arrayed him in fragrant garments and bathed him.
> And the goddess deposited for him on board a skin of dark wine,
> One, and another a large one of water, and also provisions
> In a wallet, and also put in many dainties, sustainers of vigor;
> And she sent forward a breeze unharmful at once and gentle,
> And Ulysses divine rejoiced in the breeze, and the sails expanded;
> He then skillfully was directing the course with the rudder,
> Seated; and never was slumber at all on his eyelids descending,
> As he to the Pleiades looked and Bootes the tardy in setting,
> And the Bear which also has of Wain the designation,
> Which revolves in the same place and ever observes Orion,
> And is alone exempt from the bath of Oceanus.

—The Architect and Contract Reporter.

THE POSSIBILITIES OF HUMAN LIFE WITHIN THE ANTARCTIC.

By Dr. FREDERICK A. COOK, Surgeon of the Belgian Antarctic Expedition.

IN the conditions favoring the development of human life the two zones do not greatly resemble each other. Within the arctic circle men live and thrive, and marry and are given in marriage, but explorations to the present have not disclosed the abode of human life within the antarctic circle. Indeed, in the great sweep of the earth's surface which surrounds the south pole, and extends far northward into the temperate zone, comprising one-quarter of the entire terrestrial area, there has not been found the footprint of man. There still remains an area of eight million square miles of which we know nothing. Nearly everything antarctic is vaguely known. Many of the dotted lines put down as correct lines are hardly more than guesses, but within the next few years we shall hear much of the south polar regions, hence timely questions are: "Is there human life beyond the threshold of the known?" "What are the possibilities of man in this great undersurface of the globe?"

The questions can only be answered by deductions from what little is actually known of the far south, and by analogy with the antipodes. In the region close to and beyond the antarctic circle the line of perpetual snow extends to the seashore. It is only an occasional island, or a cape extending some distance into the open waters with a northerly exposure, which is free of snow for a few short weeks in summer. The larger lands are forever hopelessly buried by a sheet of ice, and the coast is almost everywhere made inaccessible by a nearly continuous glacial wall of ice from 50 to 200 feet high. Here there are no trees, no plants, except the small hardy mosses and lichens growing upon the rocks which are too steep to afford a resting place for snow. The average temperature is extremely low, though the extremes are not as great as in the arctic. In the north I have seen the thermometer rise to 60° above in summer, and sink to 53° below in winter; but in the antarctic, while it sank to 45° in winter, it did not rise to 2° above zero during any day of summer, but the temperatures are probably not so destructive to human life as the high humidity and the never-ceasing storms. In the antarctic it blows and snows almost continually from month to month throughout the year. All of these lands are far from other lands, where man has always had a more promising prospect. They are isolated in the great antarctic sea, which combines the accumulating fury of the Atlantic, Pacific and Indian Oceans. They are guarded by a great circumpolar drift of pack-ice. All of this, combined with the overland sea of continental ice, leaves little hope for present or future homes of human struggles around the south pole.

Man is, however, a hardy animal. He is often able to adapt himself to seemingly impossible conditions. In the past he survived when other forms of life became extinct. In the future, as the favored countries become too densely populated, which they are sure to be in a few centuries, he will push to the utmost reaches of the earth, and then, I am sure, the uninhabited quarter of the globe around the south pole will not be neglected. We can hardly indicate in what direction the still unknown resources of the far south will develop. If it had been suggested ten years ago that Cape Nome and the Klondyke regions would support more than a hundred thousand people to-day, it would have been regarded as a wild dream. If two hundred years ago it had been asserted that the icy polar seas would support an industry netting billions of dollars, and employing, for a long time, thousands of seamen, as the whale and seal fisheries have done, it would have been thought impossible. It is equally impossible to deny the future possibilities of the antarctic.

I have cited the difficulties which man must overcome in order to make his home in the frozen south, but there are certain known conditions which are also favorable. The freedom of the sea and its perpetual covering by a moving sheet of ice makes migration of animal life easy, and renders the conditions similar around the entire circle. There is not, as in the arctic, a congestion of life in a few favored spots separated by a hopeless expanse of barren wastes. All around the south pole there is a fairly equal distribution of seals and penguins, not in great assemblages, but in small accessible groups. These animals, combined with the gulls and petrels, would easily and safely furnish the necessities of life of adapted man. Such a life would be hard, measured by our standards, but it would be a luxury to the Eskimo. I am certain if a clan of Eskimos were transplanted to the coastal fringe of the antarctic, they would find there a certain and inexhaustible supply of material for food, fuel and clothing from the indigenous animals. The conditions would be similar to their arctic homes, but there would be fewer feasts and no famines. Aboriginal man would surely find an easy home in the far south.

To whom do these far southern lands belong? Here are millions of square miles which are seemingly unclaimed. At least there are no valid claims filed, except those which accrue from right of discovery. Victoria-land would seem to belong to England, but it is possible for the United States to lay a strong claim by right of extension of territory. Wilkes, the American explorer, was the first to see and chart the great masses of land of which Victorialand is a part. The work of Ross, though better in quality, is supplementary to that of Wilkes, which gives the United States a priority claim. There is here also a small French claim. There is, indeed, room for a future boundary dispute of the limits and claims of American, English and French in Wilkesland. The British government seems to have no doubt on this question, for twelve years ago the Queen issued a grant for Possession Island, making Mr. Albert McCormick Davis, of Montreal, a colonial governor of its numerous cities of penguins, and giving him for a stipulated period a monopoly of its guano beds. Mr. Davis never rose to the dignity of being the first South Polar king. He was content with the honors of appointment, and returned his credentials three months after their issue.

Peter and Alexander islands, and one or two islands of the Sandwich group, belong to Russia. The Bellany, Biscoe and Sandwich groups, as well as Enderby and Kemp lands, belong to Great Britain. Grahamland, like Wilkesland, offers many bones of contention. The entire southern coast should belong to the United States. A part of the eastern coast and a part of the still uncharted weastern coast belong to England. Norway has a claim for about two hundred miles on the eastern coast. The recent discoveries of the "Belgica" give to Belgium the most beautiful and the most useful body of water in the entire antarctic area.

It is generally held that all these countries belong to nobody; indeed, that they are not worthy of ownership; but this is not true. The issue of a grant for Possession Island is an indication of the sentiments of England; another indication is to be perceived in an incident which happened a few years ago. The Argentine government, being anxious to secure possession of the South Shetland Islands, probably for the harbors and the possible values of the fisheries, made some preparations to place a lighthouse there, and thus take possession by right of prior occupation. In response to this, according to a rumor said to have been based on official instruction, a British cruiser was ordered to speed as soon as the Argentine steamer left port to the South Shetlands and there receive the Argentinos.

I must beg leave to differ with the prevailing opinion regarding polar exploration, that there is no commercial or material reward commensurate with the expenditure of time and money. In the antarctic there are several prospective industries, and much of the future work has a direct bearing upon commerce. There are seals, penguins and whales in abundance around the circumpolar area. Fur seals are nearly extinct. The various varieties of the antarctic seals have a coarse coat of single hair which is useless as fur; but the skin and oil are of considerable value. There is no reason why a profitable fishery could not be prosecuted, like that off the coast of Labrador and Greenland. The penguins are not widely known to commerce, but their countless millions will surely attract enterprise and yield some useful product. Already they are being taken at the Falkland Islands, for the oil they possess. We must abandon the hope that right whales, possessing the prized whalebone, exist here in numbers sufficient to warrant a promise of future whaling. Ross reports having seen right whales, but a diligent search since has failed to confirm this report. From the "Belgica" we saw no whales of this variety; but finback and bottlenose whales were seen in great numbers. These are small whales having no bone of commercial value, and a somewhat inferior quality of oil. But the hunt for a similar variety of whales in Norway has given profitable employment to thousands of men in the past ten years. Whaling and sealing in the antarctic cannot, however, be made to pay the enormous expense of fitting out from Europe or North America for so distant a hunting ground. To make these industries successful, permanent bases must be established either in the antarctic, on the sub-antarctic islands, or in the southern ports of South America or Australia.

The guano beds of Possession Island offer an enterprise which seems to promise certain results. The guano is rich in nitrates, and exists in quantities sufficient to keep a fleet of cargo vessels occupied for years. Similar islands may perhaps be found off the coast of Grahamland, or among the partly known groups such as the South Shetland, Bouvet, Prince Edward, or Macquarie Islands.

Our geological knowledge of this area is still too imperfect to offer even a guess of the probable finds of precious metals or gems. Arguing by analogy, the South Shetlands in general appearance, and in what little is known of the geological formation, resemble Tierra del Fuego, and we now know that here gold is found in paying quantities. Since these islands are an extension of the Fuegian Islands, is it unreasonable to expect to find gold here? An antarctic Alaska is by no means beyond the future possibilities.

There is one train of industries for which the antarctic and sub-antarctic regions offer the best conditions of the globe. This is the farming of fur-bearing animals. It is an industry which is still in its infancy, but recent experiments upon the barren Alaskan Islands have been eminently successful. There are thousands of isolated islands in the southern oceans which offer just the conditions for the cultivation of such life. These islands, though almost barren of vegetable life, are fertile with birds and seals and smaller forms of marine life, which will offer food to prospective generations of transplanted animals. So far as I know, this is a new suggestion to the prospective south polar possibilities, but the conditions which I have seen are too favorable to be ignored. The antarctic lands lie isolated in a deserted and frozen sea. The drift-ice and the overland mass of glacial ice bar the passage to adventurous travelers who seek to penetrate the mysteries of the frozen south. But it is just these barriers

which fence the "land of promise" for the coming fur-farmer, who is to take the place of the life-destroying hunter. I am sure that in the near future these wild wastes of the antarctic, with their million of bird-inhabited islands, will form an island empire of thrifty fur-farmers. What nation shall guard the interests of this coming race of hardy pioneers?—The Independent.

CHINESE SACRED LILY.

IN the opinion of a writer in Country Life Illustrated the Joss or sacred lily has been very much over-rated, and he says if the readers would only grow the ordinary varieties of the polyanthus narcissus in the same way they would get infinitely better results; they would get much dwarfer foliage, much more handsome trusses of bloom. I should, he says, however, recommend that instead of growing them with stones at the bottom and then water all round about them, to plant them in china jars, putting a little charcoal at the bottom, and then filling up the jar with a mixture of plain cocoanut fiber refuse and ground oyster shell in the proportion of four parts of one and one of the other. Great care must be taken to keep this fiber moist at all times, and this is easily done by filling the jar with water about once a week, and then tipping it on one side and letting any surplus water drain off. This will keep the fiber in an even state of moisture, and the bulbs will always do well, as is demonstrated by the photographs which are taken from nature and here shown. A further advantage also of these polyanthus narcissi is that they may be obtained at a half or a quarter the money of the so-called sacred lily, which is quite a wrong name, for it is nothing more nor less than a poor variety of the polyanthus narcissus.

ROBERT SYDENHAM.

[Continued from SUPPLEMENT, No. 1276, page 20467.]

THE MEANS OF DEFENSE OF ANIMALS.—III.*

THE PROTECTION OF THE FOOD SUPPLY.

IN considering the limitations of the food supply as one of the causes of the struggle for existence, it was pointed out that the limitations in the case of one species may be much narrower than in another; that many animals have so varied a diet that when one kind of food fails they are able to fill its place with another kind. At times, when climatic conditions are exceedingly unfavorable, famine and starvation occur on a large scale. The experience of man and of other animals shows the advantages which result from a storage of food, for a longer or shorter period, to meet the vicissitudes of life. We shall see that this storage is far more widely spread among living things than is ordinarily imagined; and its importance as a means of defense, both direct and indirect, can also be proved.

The necessity for food exists in the quiescent egg as well as in the moving adult, in the hibernating and in the æstivating mammal, reptile, fish, or insect, although this necessity is supplied in different ways. Only such animals as are capable of passing into the state of latent life, such as the Rotifers, the Tardigrades, and a few other lowly organized forms, which suspend all the living functions for a longer or shorter period; these do not require any protection of the food supply during that time. The more helpless an animal is, the more necessary does this protection of its food supply become. This applies especially to the earliest stages of individual existence, and leads us, at once, to recognize that protection of the food supply is, among animals, accomplished in two different ways:

A. The protection of the food supply is insured for the young by the parents; and

B. The food supply is insured by animals for their own individual selves or their fellows.

A. 1. FOOD OF THE YOUNG PREVIOUS TO HATCHING OR TO BIRTH.

Food is required and is used by the young on beginning its development within the egg, and is lodged in the egg itself, in the form of yolk. This yolk may consist either of fats and oils, or of albumens, or of both of these kind of substances. We have already dwelt on the relative amount of yolk, or food material, in different eggs, in Lecture II. From the present point of view we have but to point out that the smaller the quantity in a given egg, the sooner is the young animal compelled to rely on its own exertions for its nourishment, unless indeed it be one of the viviparous kind. Where the eggs are more or less richly provided with food-yolk, its source is either the cells of the female ovary, which furnish nutritious secretions with which the eggs are charged, or special yolk glands having this function.

Among insects it has been shown that conditions exist where all the contents (cells) of each of the tubes composing the ovaries develop into eggs, while the food material to be stored in those eggs is secreted by the walls of the tubes. In others, the cells within the ovarian tubes, although all at first potential eggs, develop alternately into an egg, then a food cell, an egg, a food cell, and so on; the food cells break down into fragments and are absorbed by the eggs, which are in this way furnished with sufficient food in order to start them on their course of development. In still other insects the anterior or blind end of the ovarian tube, that which is directed toward the front end of the body, furnishes the nutriment which is conveyed by separate delicate tubes, one for each egg.

In the group of flat worms (Plathelminthes), where distinct yolk-glands exist in many species, comparative study has shown that these glands have arisen as the result of a division of labor in the primitive ovaries, a small part of these latter being confined to the formation of eggs, the larger portion furnishing only yolk for those eggs. This yolk may take the form of cells similar to the eggs themselves; so that when the eggs make use of them as food, we may well speak of egg cannibalism. Thus, in the egg cocoons of a small European flat worm (Planaria polychroa), living in fresh water, the Russian naturalist, Metschnikoff, found the contents of each cocoon to consist of four to six eggs with about 10,000 yolk cells; and primarily it seems that these yolk cells are the equivalents of the egg cells. The yolk cells, however, are swallowed by the developing eggs, so that what were originally capable of developing into embryos simply furnish food for their brethren.

Similar food relations exist in the case of earth worms, which lay their eggs in small cocoons, which are about ⅛ inch long, and are placed under logs, or in other damp situations. Each one of these cocoons, in the case of one of our common species, contains about twenty eggs, embedded in albumen; but as a general rule, only four to six out of the twenty develop. The others, for one reason or another, degenerate and remain in the albumen. When the four to six eggs which do develop reach the stage when they are capable of making movements for themselves, they move about in the albumen of cocoon and swallow it and also the other eggs which have not developed.

Leeches have a similar habit, but perhaps the best illustration of this peculiarity is that which has been observed in Gasteropod (univalve) mollusks. Prof. McMurrich has described, from his observations at Beaufort, North Carolina, the condition of affairs in a Fasciolaria. Each of its egg cases, when freshly laid, is found to contain a large number, even as many as 200 eggs, each measuring about 0·25 mm. in diameter, embedded in the usual albuminous substance and containing much yolk. But only a very limited number, four to six eggs, develop out of the entire 200. The others have actually been seen to be swallowed by those which do develop; so that here again we have a case of egg cannibalism; where, as a normal and natural process, certain eggs are always devoured by others which, for some cause or other, have the start. These statements, however, do not hold true for all the species that belong to this group of shell fish, and which lay their eggs in capsules; for in the case of the common conch (Fulgur) it is found that, as a rule, in each one of the egg capsules only twelve to fourteen eggs are placed, and that all these develop, so that even in the same group of animals a very considerable divergence in these respects may exist.

Even among vertebrates, a food supply for certain

POLYANTHUS NARCISSUS.

eggs at the expense of others has been discovered in the viviparous, European, Black Salamander. In either side of the uterus of the female of this species are forty to sixty eggs, of which usually but one develops; the other eggs, "dissolving," form a common yolk mass, which is consumed by the developing egg after its own limited yolk supply is exhausted.

It will doubtless occur to many minds that where one or a few eggs are developed at the expense of many others, an appreciable increase in the rate of mortality must be the result of this method of insuring the food supply of the young. While this is doubtless true, it is also evident that the great waste among eggs of many oviparous animals is here enormously reduced, or altogether avoided, and that the total output of the ovaries is consumed to the direct benefit of the species. On this question, as on so many others in biology, statistics do not exist, and a comparison of the results of the two habits on the rate of mortality has yet to be made.

The instances just described, where a few eggs develop at the expense of others inclosed within the same egg cocoon, lead naturally to those, apparently few cases, in which the young, on completing their embryonic development within the body of the female, obtain their next meal by feeding upon her internal organs while she is still alive. This is recorded for the peculiar viviparous threadworm Ascaris nigrovenosa and certain minute, two-winged flies.

Presence or absence of food yolk within eggs is not correlated with oviparous or viviparous habits. A priori, it might be supposed that in viviparous young, since they are retained within the female's body, all their nourishment would be derived directly from her, and the amount of yolk stored in each egg would be small; and, on the other hand, in those eggs which are set free early in their development, that the amount of yolk would be large, since such would have no other food supply. But such an expectation is not realized throughout the animal world. There are viviparous animals, such as the great majority of the mammals, in which food yolk is indeed almost absent from the egg; but the eggs of viviparous scorpions, of certain viviparous star fishes and of a few other forms, are well supplied with yolk. Among oviparous eggs, there are many that have very small quantities of food yolk, such as the great majority of star fishes, the bivalves (like the oyster and the clam), while oviparous eggs with much food yolk within them include those of birds, most fishes, reptiles, spiders, and insects.

In those viviparous animals, even where the eggs are well supplied with yolk, the nourishment for the young, previous to birth, is sooner or later furnished by the blood or by special secretions of the female. In the placental mammals, foods contained in the maternal blood are absorbed therefrom by the blood or tissues of the offspring, without any mixture of the two bloods. The source and the mode of transfer of the food is the same in the placenta of probably the only reptile possessing such a structure, Seps chalcides of southern Europe; and in the wrinkles and folds of the walls of the oviducts or ovaries of viviparous sharks and many minnows. In the black salamander and in the eel pout there is a rupture of blood vessels, followed by a discharge of blood and serous liquid into the cavity of the uterus, or of the ovary, where the embryo is lying; and this blood is then absorbed by the embryo and so furnishes it with food.

While the peculiar uses of egg cannibalism, of parent cannibalism and of viviparity are interesting and striking, we must not lose sight of the fact that the very great majority of animals are oviparous. The eggs of most of these are furnished with no other food supply than that stored within them as food yolk. Egg yolk is, therefore, the initial food supply of animals in general; and its importance as a means of defense in the struggle for existence cannot be overestimated.

A. 2. FOOD OF THE YOUNG AFTER HATCHING, OR AFTER BIRTH.

In a great number of animals—more especially insects—the eggs are placed by the female upon or in the substance which is to form the food of the larva after hatching: so in the butterflies, moths, beetles, carrion insects of various groups, etc. The fly Drosophila ampelophila has the habit of laying its eggs in soft, decaying fruit; the egg is provided with two small projecting arms that prevent it from slipping down below the surface of the soft pulp; for if it should, it would be, so to speak, drowned or smothered in its food, and since the egg hatches at the upper end (the part which remains above the surface of the fruit), the larva is in such a position as to enable it to feed with the greatest ease and to the greatest advantage. The food which is provided for the young of many wasps after hatching consists of insects which are placed in burrows, tunnels, or mud-cells close to the egg. The food-insects which are thus placed may either be dead, or alive although paralyzed. When dead, they are, of course, liable to decomposition; only a few can, therefore, be stored with the egg; and when these are consumed by the young larva, the parent brings additional dead provender to the nest for the benefit of the young (Bembex, Philanthus). In other, but related, genera (Scolia, Sphex), the nest in which the egg is contained is provisioned once for all with paralyzed, but still living, insects The paralysis is accomplished by the parent wasp stinging the food-insects in one or more of their nerve ganglia, so preventing the victims from using their jaws or their legs. So effective is their paralysis for this purpose that experiment has shown that insects so treated may live for several weeks. After hatching of the wasp-egg, the larva feeds upon these paralyzed victims. In several species the wasp-larva's existence has been shown to depend upon the continued, living condition of the prey while being devoured, and that the head of the devourer must remain at the same point at which it was first placed upon the body of the victim, otherwise the latter is liable to die. It may be that we have a peculiar case of preservation of the food supply during its consumption, and that changing the feeder's position from the point at which it had first broken the skin of its victim would expose that broken portion to the entrance of bacteria, or of mould, or to dryness resulting from evaporation.

Just as, in birds, the cuckoo and the cow-bird place their eggs in the nests of other species, so that their young, when hatched, are fed by foster-parents, so it appears that the same habit exists in certain insects. Thus the two-winged fly, Miltogramma, lays its eggs on the insects with which the wasp, Bembex, provisions its nest. The larval Miltogramma, on hatching, feeds first on this provender, then on the rightful tenant, the larval Bembex, and is subsequently furnished with fresh insects by the mother Bembex, who seems to make no effort to expel, or to kill, the intruders who thus prey with deadly effect on her race. (See for details, Sharp's Insects.)

The habit of supplying young animals with the disgorged food of the parents is quite widespread. Thus, honey is plant-nectar which has been changed from cane sugar into grape sugar during a sojourn in the crop of the bee. It is subsequently brought up again and placed in cells in which the bee's eggs have been laid or may subsequently be placed; it may be mixed with more or less pollen. So, also, ants feed their young, as well as the full-grown individuals, with the regurgitated contents of the forepart of their alimentary canal. Audubon says of the passenger pigeon, "The old bird introduces its bill into the mouth of the young one and disgorges the contents of its crop;" and of the carrion crow, or black vulture, "The young are fed by regurgitation almost in the same manner as pigeons, and are abundantly supplied with food." When it is recalled that the black vulture feeds upon carrion (as its other name indicates) and regurgitates this carrion to feed the young, it will be seen what a peculiar (and disgusting!) case of providing for the food supply of the young this is.

The possibility of feeding the young with disgorged parental food, as found among social insects like the ants and bees, is accompanied by another advantage, namely, that some, at least, of the full-grown individuals of the colony are always with the young, able to supply them with food without going to seek it and thus giving them, at the same time, the protection of their presence. In other animals, such as birds and some insects, as some of the wasps to which we have already referred, a great element of danger is introduced when the parents, one or both, leave the nest to obtain additional food. The mammals have avoided or overcome this difficulty by a means which is, to a certain extent, like that of the ants, that they feed the

* A series of lectures delivered January and February, 1900, at the Academy of Natural Sciences, of Philadelphia, by Philip P. Calvert, Ph.D., of the University of Pennsylvania. Copyrighted, 1900, by Philip P. Calvert. Revised by the author.

young with a product of their own internal organs, milk; and, as the mother is not separated from her young thereby, a greater protection is afforded.

The secretion of milk occurs in all the mammals, although qualitatively it may be different in the lowest group, or Monotremes (represented by the peculiar duckbill of Australia and its relative, the Echidna, where the egg is either simply hatched in the sand or is received into the brood-pouch of the mother Echidna). Here the milk-glands appear to be modified sweat-glands; whereas, in all other mammals, they are modified oil-glands.

Apparently the only other instance of the young feeding upon the secretion of the parents is that of the pigeon. For two or three days previous to the hatching of the egg, and for the same period afterward, the crop of both parents acquires the power of secreting "milk," which, mixed with food in the crop, is fed to the young. Pigeon's milk is quite similar to that of mammals; it does not contain any sugar, however, and the proportion of water is less. In this aspect of the subject it is of some importance to point out that a further protection of the food supply of the young obtains in all larvae of bees, ants, wasps, and, in fact, all those hymenopterous insects related to them (Aculeates), by reason of the stomach lacking any posterior exit; consequently, no fouling of the food supply stored up within the nest can take place.

In leaving the subject of the food supply of young animals, we may briefly allude to the protection of this supply in the case of parasites. Bathed in the contents of their host's intestine, or washed by the constant stream in his blood vessels, or embedded in his muscles, or devouring a path through his subcutaneous tissue, so sure is the provender that the luxuriating parasite can dispense with most of the organs found necessary to other animals, and know no famine so long as his host lives. The latter's survival is usually for a sufficiently long period to enable the parasite to complete that particular stage of its development.

B. THE PROTECTION OF THE FOOD SUPPLY INSURED BY INDIVIDUALS FOR THEMSELVES, OR FOR THEIR FELLOWS.

The mere feeding of animals cannot be considered a means of defense, any more than the act of breathing can be put into the same category: both are actions comprised in the very act of living itself. That which does concern us is to discover in what ways, consciously or unconsciously, an abundance of food today is applied to to-morrow's need, so that the individual may continue its part in the struggle for existence. The most general method by which food is laid up for the morrow is in the formation of fat from surplus food, and its deposit in the various tissues of the body. On the other side of the account, experiment shows that in a starving animal it is this deposited fat which is first used up to meet the demands of the other organs, which must continue their accustomed action, irrespective of whether food enters the body from without or not. Such stores of fat also enable hibernating animals to carry on their lowered activity during their winter sleep, the quantity of fat which exists within their bodies at the end of the winter being very much less than that at the beginning.

Storage of food within the body as fat is a more or less complicated process, involving, usually, a chemical change of the products of digestion. A simpler mode exists in not a few forms where food is stored even before mastication. Such methods obtain in the Ruminants; and while the food is unquestionably prepared for subsequent mastication by being macerated in the so-called first stomach, yet it is doubtless an additional advantage to these animals to be able to store their food temporarily in this place, and to postpone rumination on those occasions when flight may be necessary to carry them beyond the reach of a carnivorous foe.

Similarly the cheek-pouches of various rats and monkeys, of the duckbill, the crops of carnivorous birds, the beak-pouches of the pelicans—all structures where considerable quantities of food may be retained for a shorter or longer period and thus kept for the use of its possessor, out of reach of competitors—all these play a part in the protection of the food supply. One of the most singular of these receptacles, in its effect on outward form, at least, is the crop in the so-called honey-pot ants, or honey-bearers. These are considered by Dr. McCook to be, not a distinct caste in the nests in which they occur, but workers which store considerable quantities of nectar of flowers in their crops, with the result that the animal appears to consist of an enormously distended abdomen in comparison with the size of the head and thorax. These so-called honey-pots, or honey-bearers, regurgitate this food at times when the supply of nectar outside is limited; and it appears that all the members of the colony are accustomed to congregate around these honey-bearers and to obtain some of this regurgitated honey from them.

A few animals literally store their food in hiding places. We may mention the squirrels and the beaver. Morgan states of the latter that as many as nine individuals in company have been observed to fell trees, to cut the branches into proper lengths; to transport them to the vicinity of their lodges; to sink them below the water and to weight or fasten them down, by the aid of brush heaps thrust into the mud at the bottom of the stream in which the beavers live. It is the bark on the surfaces of such branches which furnishes the nutriment and enables the beavers to thus retain a supply of food for the winter.

The harvesting ants, found in Europe, North America, and Northern Africa, are so called from their habit of gathering seeds and other portions of plants and storing them in chambers which form parts of their underground excavations. Dr. McCook has even observed in certain North American species, that after the seeds have been dragged into the ant excavations, the husks are stripped off and carried away, while the seeds, being the nutritious portions, are those which are stored.

Doubtless the most certain way of insuring a food supply is that which man has adopted in his practice of agriculture. The naturalness of this effort to aid himself in the struggle for existence has no better evidence than the checks which it, in common with the struggles of all animals, meets in the climate and in plant and animal foes. Hardly credible is it that other animals than man should also practise agriculture, so great is human self-conceit! Yet it seems well established that here, as in so many other activities of social life, ants have achieved remarkable success. The leaf-cutting ants of tropical America carry pieces of leaves into parts of their nests, and on these pieces a fungus grows. The ants tend this fungus, which, under their care, produces peculiar growths which furnish food to the cultivators. When the same fungus is grown unattended by the ants, these peculiar growths are not formed.

A. MÖLLER.

WINGED MESSENGERS.

UNDOUBTEDLY few pastimes have ever so suddenly achieved popularity in England as that of flying pigeons, and yet our fathers were addicted to the sport, though in the pre-telegraphic days there was more of business about it than there is now, as Bell's Life and other sporting papers were compelled to rely largely upon the pigeon post for the very latest information they received from the training quarters. The serious aspect of what is a source of innocent amusement to many thousands of our countrymen has, moreover, been fully recognized by our own and foreign governments of late years, in fact almost every civilized nation has now its government lofts, the British establishments of the kind being three in number, one of which is situated at Sheerness, a second at Portsmouth, and the third at Devonport, all of them being under the control of the Admiralty.

It is quite reasonable, however, to imagine that the immense services rendered by flying pigeons not only to the military authorities, but to the public at large during the siege of Paris, and more recently in South Africa, where some Durban fanciers offered the loan of their birds to General White shortly before Ladysmith was finally invested, will have the effect of inducing the War Office to devote more attention to the establishment of lofts. The success of the Durban pigeons has indeed confirmed the good opinions already formed of the value of the homer in time of war, and consequently these birds are likely to receive still more attention from the public, especially as it will be remembered to his credit that the homer rendered good services to the Alert and Discovery Polar Expedition years ago.

It may here be mentioned that the term carrier, as applied to the racing or homing pigeon, is a misnomer which betrays a great ignorance of Columbarian subjects on the part of the person using it, as the carrier is a very old-established variety of fancy pigeon, which is not only as unlike the subject of this paper as two birds could be, but is so abundantly provided with flesh-colored wattle upon its beak and eye that it is probably incapable of finding its way home from a distance of a quarter of a mile. The homer, or racing pigeon, as it is now the custom to style the bird which carries the messages, in order to distinguish it from the so-called show homer, a cumbersome-sized offshoot of the true variety, and by comparison quite useless for active service, is a comparatively recent production, as it is a result of the judicious crossing of various flying breeds, such as the real Antwerp and the Smerle: and probably, also, the dragon, the high-flying Cumulet, and the owl are also represented in the original strain. No doubt it was the enterprise of the Belgian lovers of pigeon racing which contributed originally to the development of the modern voyageur. Certainly no other country in the world can claim the possession of more enthusiastic and devoted supporters of the pastime than Belgium, and it was from there that H.R.H. the Prince of Wales obtained the first homers he ever possessed, the pigeons being a gift to him from the King of the Belgians. This was in the year 1886, but the birds were not trained, being confined in aviaries for breeding purposes, and they were crossed with most satisfactory results in the year 1888 with some others also received from the King of the Belgians.

Since that time the Prince of Wales has been very constant in his liking for racing pigeons, but it was not until last year that His Royal Highness achieved the chief object of every owner of flying pigeons by winning the great annual race from Lerwick, N.B. The bird which accomplished the feat is a handsome blue chequer cock, with good wing butts and plenty of feather, and was bred by the Prince rather late in 1897, so that he was not trained as a youngster. In 1898, his training was accomplished by tosses at the following distances: Three miles; 20 miles, Boston; 115 miles, Dewsbury; and 117 miles, Whitley, near Newcastle-on-Tyne. Last year his stages were two miles, Boston, Lincoln, York, Whitley, Banff, and Lerwick. His sire was a blue cock, bred by the late Mr. George Chisem, whose father and mother had both flown from Rennes; while the dam of the Sandringham crack was a blue chequer bred by the Duke of York from a pair of birds the gift of Mr. F. Duchateau, of Quevaucamps, and a very consistent worker herself, as she had flown all stages from Arbroath, N.B.

The other pigeon illustrated is the blue cock, bred and owned by H.R.H. the Duke of York, which took the third prize in the Lerwick race. This bird was hatched in 1895, and as a youngster flew from Sheffield and Leeds; in 1896, after three preliminary tosses, he flew Lincoln, Doncaster, Northallerton, Newcastle, and Banff; while in 1897 he did all the usual stages to Arbroath and then jumped to Lerwick. He is by no means a big pigeon, but he is well feathered and furnished with a very bright eye, though he has not the appearance of a bird which could stand a lot of rough work; but the fact that he flew Lerwick in 1897 and again in 1899 proves that his heart is in the right place. It may be mentioned, too, that in spite of the successes of the Sandringham birds in the big race last year, they were handicapped by the proximity of their lofts to the Wash, as owing to the dislike pigeons possess to crossing a wide expanse of water if they can avoid it, they go rather out of their way to come over where there is a narrower strip of sea beneath them.

The interior of H.R.H. the Prince of Wales's loft is divided into two compartments for old and young birds respectively, the nest-boxes being a special feature of the establishment, and they are so constructed as to be easily removable. The birds are fed from hoppers, and after the breeding season is over the nest-boxes are closed and old and young birds are allowed the use of both lofts. During the months of January and February the sexes are let out alternately, but with the exception of these months the birds have a free loft, and may generally be seen about the lawn or flying to and from the adjacent fields. During the winter months the cocks are kept in the inner and the hens in the young bird loft, the nest-boxes being opened about a week or ten days before the birds are mated, so that each adult cock can take possession of his old box, and the young ones select theirs from those which are vacant. The hens are then placed in the nest-boxes of the cocks with which it is intended they should mate, and are confined therein until they are thoroughly paired, when both birds are let out into the loft. Although there is an aviary for prisoners, i.e., birds which have been received from other lofts for breeding purposes, and which may in consequence be likely to escape, it is the usual practice at Sandringham to give such pigeons their liberty after one of their wings have been cut, and it is generally found that by the time they have moulted and the feathers are grown they are quite content to remain where they are.

FIRST PRIZE-WINNER, LERWICK.

THIRD PRIZE-WINNER AT LERWICK.

H.R.H. the Duke of York only began to patronize flying pigeons in 1893, and his loft, being a more recent erection than that of the Prince of Wales, may in some respects be preferred to the latter. This loft consists of two rooms, and on entering it on the left is the prisoners' pen, from which access to a very good flight is accomplished by means of a small alley-way. The racing birds are in the upper chamber, and all the arrangements are admirable, though the artistic nest-boxes of the Prince of Wales's establishment are not in use here. In both lofts the birds are supplied with fresh water to drink from open fountains, which can be easily cleansed, great care being taken in handling and catching the pigeons on their return from a race. In order to insure this the traps and windows are fitted with blinds and shutters, so that the loft can be darkened without any trouble in a very short space of time. Although a few seconds may be lost by this, the system has been found to work well, and it may be commended to the consideration of other owners of flying pigeons. That these are many in number is proved by the fact that there are 600 Flying Societies in England, the principal body of the kind being the National Flying Club, of which the Duke of York is president, while the Prince of Wales is also a member of it. Perhaps, therefore, the time may come soon when the public will cease to labor under the erroneous beliefs that the carrier and the homer, or racing pigeon, are identical varieties; that the birds carry their messages tied under their wings instead of round their legs; and that a homer is capable of flying in any direction his owner desires without having been subjected to a proper course of training.—Country Life Illustrated.

More than 72,000 letters and postal cards have accumulated in the hands of the Italian consul at Christiania for the Duke of Abruzzi, who spent last year in Franz Joseph Land. A whaler will try to communicate with the expedition as soon as the ice breaks up.

ELECTRICAL ENERGY FROM PEAT.

STAHL UND EISEN contains an article in which the author, Dr. Frank, proposes to utilize the great peat beds of North Germany for the production of electricity on a large scale. He estimates that a hectare of turf, three meters thick, gives 2,500 tons of dry turf, equivalent to 1,200 tons of coke, or in English measure, an acre of turf, 10 feet thick, gives 1,000 tons of dry turf, equivalent to 480 tons of coke. The mosses of the Evus Valley, which cover an area of 1,000 square miles, might furnish the equivalent of 300,000,000 tons of pit coal; that is to say, more than the total production of Germany for three years. The turf would be burnt at central stations of 10,000 horse power capacity, consuming annually 200,000 tons of turf, the product of 200 acres of the beds. One application of the power produced would be to the service of the canal connecting Dortmund to the Evus, which will soon be finished; but the author thinks the most interesting will be the manufacture of acetylene, the materials for which can be obtained easily and cheaply in the neighborhood. With 10,000 horse power, a quantity of acetylene can be produced daily equivalent for lighting purposes to 150,000 gallons of petroleum, or annually in value to 20,000 tons of foreign imported petroleum.

ELECTRIC LINES OF FORCE.

A GOOD photographic tracing of electric lines of force may, according to W. Schaffers, be obtained in full daylight by the action of the secondary circuit of an induction coil upon a sensitive plate. Two needles form the terminals of the circuit. One of them is placed in contact with the sensitive film of a silver bromide or (better) lactate plate, while the other is held about half a millimeter above the surface some distance off. The former should be made the positive, and the latter the negative terminal. If both points are in contact with the plate, the wandering globules discovered by Leduc interfere with the tracing. The lines of force begin to trace themselves by a great number of small black lines resembling arrows, which point from the positive to the negative pole, and which under the microscope resolve themselves into a mass of ramifications. The traces are not dissolved by "hypo," and hence the plate may be made transparent and used as a negative. No developer is required, as the traces appear at once in black. Quicker action may be obtained by diminishing the proportion of gelatine in the film. The formation of the traces commences with the fusion of the silver salt, and the blackening is due to the carbonization of the gelatine. After a while, the bromide is reduced also. Gold iodide gives brown continuous tracings communicating with each other by numerous branches. Sometimes their formation is almost instantaneous. But these traces cannot be fixed.—W. Schaffers, Comptes Rendus, April 2, 1900.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Electric Street Cars in Newfoundland.—Electric cars are now in operation on the principal streets of St. Johns, and hundreds of people from the outports have come to enjoy, with the inhabitants of the city, the strange sensation of being whirled along by such peculiar motive power. The street railway is operated by the trolley system and will run twenty cars over seven miles of track; as the traffic increases, the line will be extended to all the suburbs.

The current which provides the power, as well as that for lighting, is generated nine miles from St. Johns. The physical characteristics of the region lend themselves admirably to the success of this enterprise. There is a chain of four connecting lakes, and from the outlet of the last runs a flume, which is built along a steep hillside for 3,300 feet, until it disappears into a tunnel cut 350 feet through a bluff of solid rock. At the end of the tunnel is erected a huge sluice box of timber, to the bottom of which is fixed a steel tube six feet in diameter. Through this the water drops 185 feet on a large water wheel in the power-house, which sets the machinery in motion. The largest of the lakes supplying the water has a superficial area of 31,000,000 square feet; the next, 15,000,000; the third 9,000,000; the fourth, 1,000,000, this being used as a regulating pond. The capacity of the plant is 1,600 horse power, but the flume is of sufficient capacity to drive another plant of like size.

The electricity is concentrated at the power house and transmitted to the sub-station in St. Johns at a voltage of 15,000. To-day, every portion of the apparatus was in circuit and every wire charged, the whole running as smoothly as if it had been going for years. The water wheel and other machinery was built by the Stillwell, Bearce, and Smith-Vail Company, of Dayton, Ohio, and the electric plant by the Westinghouse Company, of Pittsburg, Pa.

The street railway is a subsidiary enterprise associated with the railway between the government of Newfoundland and Robert G. Reid, of Montreal, in 1898, an account of which was published in Consular Reports, No. 213 (June, 1898), p. 201.—Martin J. Carter, Consul at St. Johns.

Manufacture of Sauerkraut in Magdeburg.—The best German sauerkraut is made in Magdeburg; but when a consular officer attempts to ascertain how it is made, he encounters the usual insuperable obstacle—business secrets. The manufacturer politely replies to all inquiries, "My recipe is what makes my business profitable. If I gave it to you, you could make the same sauerkraut in Washington. The fame of Magdeburg would thus be dimmed, and what would become of the orders which mean so much to me?"

The process of manufacture, omitting business secrets, is about as follows:

Take a number of heads of white cabbage, as fresh as possible, and cut them into fine, long shreds. Place in layers in barrels, or kegs, strewing salt over each layer, using one-half a pound of salt for each twenty-five cabbages. Press the mass down with clean feet, wooden shoes or a heavy stamper. Place a cover on the barrel, and upon this lay a heavy stone. This presses the sauerkraut more and conserves it better. The sauerkraut must then be allowed to ferment in a cellar for from three to eight days, according to the temperature of the room. The barrel should then be tightly closed and kept in a cool place, preferably in a cellar.

Fancy grades of sauerkraut are produced by pouring white wine into the barrels after they are filled. Apples chopped very fine are also sometimes mixed with the cabbage. After the barrel is closed, the sauerkraut will be ready for use in about a week. As soon as some is used the barrel should be covered and a stone again placed on top. In preparing and keeping sauerkraut, sunshine and extremes of heat and cold should be avoided.—George H. Murphy, Vice-Consul at Magdeburg, April, 24, 1900.

Doll Trade in Thuringia.—The toy trade may be traced back in Thuringia to the middle ages; it is the predecessor of the doll trade, which is of a much later date, the first doll having been manufactured about forty or fifty years ago, says Oliver J. D. Hughes, U. S. Consul at Coburg.

Simple as a doll may appear at first sight, the work needed for its completion is complicated.

The commonest kind of doll now in the market is the one which goes under the name of "wax doll." Its trunk is made of cheap shirting, stuffed with sawdust or excelsior; its legs and arms and head are usually of papier-maché, the last having a thin wax covering; a coarse shirt completes this very poor and simple type of doll, and yet many hands have been engaged in getting it ready. Certain workmen make the arms and legs, either by cutting them out of wood or moulding them of papier-maché; others arrange the limbs in flat, wooden boxes, which are put near the stove or in the sun to dry; others dip the arms and legs into a basin containing red dye, to give them a flesh-like appearance; others sew, cover, and stuff the doll; others paint the eyebrows, lips, and hair; if this last be not merely indicated by paint, mohair is glued on. The manufacture of the glass eyes, as well as the fixing of the same in the head, is again done by different people; and all the parts are put together by a small manufacturer, who usually lives in town and to whom the workmen engaged in the manufacture of parts of dolls carry the product of their weekly toil.

Model dolls are quite similar to the wax dolls, with the exception that they are provided with heads made entirely of wax.

In the manufacture of mat dolls, the limbs and heads are dipped into a solution which is supposed to make them washable.

The making of fine doll wigs must be considered an art by itself. Mohair, which is imported in large quantities from England, is used in this manufacture; sometimes human hair is employed, but the latter material being expensive, its use will always be limited.

The consumption of China bisque heads is very large, and about a dozen factories are engaged exclusively in manufacturing them, two new ones now being built in this district.

The mass out of which china heads are made consists of china clay, quartz sand, feldspath and kaolin. These materials are put into iron drums and mixed, ground between flint stones and wetted. The mixture is filled into hollow gypsum forms, and remains long enough to allow part of the mass to settle on the inner surface of the mould and become firm. The remainder is poured out again, and the gypsum forms, which consist of two parts, are removed so that the china heads in their unfinished state are left. Before they have become quite hard, all roughness is removed from the surface, and the spaces for the mouths and eyes are cut out. Next, the heads are exposed in ovens to an intense heat for about three days; they are then painted and placed for a few hours into another kind of oven, so that the paint is burned in.

The glass eyes are blown out of tubes held over a strong gas flame; they are connected by wire, and, if it is desired to make them movable, a lead weight is fastened to the wire.

The dressing of dolls is also an extensive industry. Manufacturers employ up to 200 or 300 hands—mostly girls. Of recent years, dolls are brought out dressed in uniforms to represent some well-known character. Dolls dressed in khaki are now being put on the English market. In this district, cheap goods are mostly manufactured.

Land Grants in Ontario.—Commercial Agent Shotts writes from Sault Ste. Marie, May 10, 1900:

The government of the Province of Ontario has granted a bonus to the Algoma Central Railway of 7,400 acres of land to the mile of road. This road had previously received a money bonus from the Dominion government of $3,200 per mile. It is to run from this city to Dalton, on the Canadian Pacific Railway, with a branch to Michipicoten, in all about 200 miles, through a mineral and timber district. The land will probably become very valuable. One of the considerations of the bonus provides that the company must bring one thousand settlers into the district each year for ten years. The railway is owned by the Lake Superior Power Company, composed entirely of citizens of the United States. This company now has one of the largest mechanical pulp mills on the continent located here, and is building a sulphide pulp mill, smelting and reduction works, alkali and chemical works, and large ore docks at Michipicoten Harbor. It is also getting a line of vessels to carry the ore and the products of its mills.

New Enterprises in the Riviera.—In his annual report on the commerce and industries of Nice for 1899, Consul Van Buren says, in part:

Owing to the efforts of the deputy for Nice, the plan of connecting Nice with the Italian frontier via Sospel has made considerable progress. The various ministries and the military authorities interested are now busily engaged in elaborating plans, which, when fully agreed upon, will be submitted to the Paris-Lyon-Meditérranée Company, which is to build and run the line.

I am informed that the Compagnie Générale des Eaux, which has the monopoly of furnishing the water supply of Nice, has obtained possession of a copious spring in the Departement du Var, and that it intends to build an aqueduct to Nice. It is calculated that four or five years will be required to complete the work, and it is claimed that the town will then have a water supply second to none in the world.

The building of the new electric traction system by the Thomson-Houston Company is now completed, and one or two lines are running. The importance of this enterprise cannot be overestimated.

During the last year the Compagnie Electrique de la Meditérranée has been established at Cap d'Aglio, near Monaco, with a capital of 500,000 francs ($96,500). Its object is to utilize water power and to furnish electric light and power in its vicinity.

I cannot report that any direct importations of American goods have been made during the year. There are evidences, however, of a limited quantity of such goods having entered the retail trade here.

New Electric Plant in Quebec.—Commercial Agent Johnson writes from Stanbridge, May 17, 1900:

The Chambly Water and Power Company, located twenty-five miles northwest of Stanbridge, is about to add very largely to its present plant at Chambly. It intends to develop additional power at St. Therese Rapids, some three miles farther up the river. At the present time the Chambly works have 7,500 horse power, but they will be made capable of developing 20,000 horse power. The works at St. Therese will give an additional 10,000 horse power. The extension of the old works will, it is expected, be completed this summer, while the new works will take some eighteen months to finish.

Export of Gas Motors to Greece.—Vice-Consul Monaghan writes from Chemnitz, April 25, 1900:

Greece offers at this time a very good market for the export of gas motors of all kinds. The works of Athens and Piræus deliver gas to their customers for industrial purposes at very low rates. The Grecian mining industries have also increased in activity of late, causing a great demand for mining machines and apparatus. It will be of advantage to makers and exporters of such machines to investigate conditions in the Grecian market—i. e., time of payment, credits, packing, freights, tariff, etc. This would also be a good field for American gas stoves. Catalogues printed in French would, if sent, be very advantageous. The German papers are calling the attention of manufacturers to the above line of machines.

Machines and Transmitting Belts in Japan.—Under date of April 25, 1900, Vice and Acting Consul Monaghan, of Chemnitz, says:

German papers note that the increasing use of machines of all kinds in Japanese industries has caused a large import of leather and rubber belts, which will, without doubt, advance in succeeding years, as Japan has not, up to this time, taken up the manufacture of these articles.

The thriving Japanese industries also offer a good market for the export of boilers, especially tubular boilers. A great demand exists at present for drilling, planing, screw and thread-cutting machines and turning lathes.

New Dutch Steamship.—Consul Listoe writes from Rotterdam, May 4, 1900:

The Holland American Steamship Company, of this city, has increased its fleet of steamers in the direct service between Rotterdam and New York by a twin-screw steamer—the "Potsdam." The new steamer is of 12,500 tons burden, is 550 feet long, 62 feet wide, and 45 feet from upper keel to top deck. The ship is lighted by electricity throughout, and the cabins, as well as the compartments for steerage passengers, are fitted out with all modern improvements. The "Potsdam" is calculated to accommodate 200 first cabin, 150 second cabin, and 1,000 steerage passengers. It left here on its first voyage to New York May 17.

Petroleum in Algeria.—Consul Skinner, of Marseilles, sends the following, dated April 27, 1900:

M. Henry Neuberger, intrusted by the governor-general with a geological exploration in Algeria, has just furnished information as to the first part of his expedition in the department of Oran. According to his report, the West Algerian petroleum-bearing basin offers fourteen districts rich in oil, extending northwest to southeast for a length, in the southern district, apparently exceeding 124 miles. If the report of the discovery is reliable, the nature of these soils is in all respects similar to that of the rich beds of Baku and Galicia, which promises a prosperous future for petroleum exploitation in Algeria. On the other coast, petroliferous levels reappear in the department of Constantine. Applications for concessions to work these beds have already been made by ten or more financial companies.

German Emigration in 1899.—Consul Hill writes from Amsterdam, May 5, 1900:

The statistics of German emigration for 1899 show that 23,740 persons left the country to cross the ocean. There has been a great falling off in emigration since 1894, when there were 120,089 German emigrants. The decrease is due to the commercial and industrial prosperity of Germany and to the care taken by the state for the welfare of the working classes. Out of the 23,740 German emigrants, 19,016 went to the United States in 1899, and 1,089 sailed from Bremen for Brazil, against 629 in 1898. The increase is due to the concession obtained by the Hanseatic Colonization Society.

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No. 747, June 5.—*Electric Street Cars in Newfoundland—*Manufacture of Sauerkraut in Magdeburg—Taxation in the Canary Islands Colombian Match Monopoly—Freight Rates from Puerto Colombia to Barranquilla.

No. 748, June 6.—German Imports of United States Goods in 1899—*Export of Gas Machines to Greece—*Machines and Transmitting Belts in Japan.

No. 749, June 7.—Trade Conditions in Brazil in 1899—Pulp Mills in Ontario—*Land Grants in Ontario.

No. 750, June 8.—German Photographers' Exhibition—New Steamships—Imports into Germany from its Colonies—*Petroleum in Algeria—*German Emigration in 1899.

No. 751, June 9.—*Winter Route to Dawson—Inspection of Food in Gibraltar—Dairy Interests in New Brunswick—*New Electric Plant in Quebec.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Menthol Sticks are produced as follows: Melt 2 parts of cocoa butter and 4 parts of spermaceti, and add 1 part of menthol (crystallized) and 1 part of chloral hydrate. This mixture is then poured into suitable moulds.—Praktischer Wegweiser.

Polish for Metals.—For polishing metals the following medium is recommended by the Centralzeitung für Optik und Mechanik:

Heat 8 to 9 parts of stearine, 32 to 38 parts of mutton grease, 2 to 2·5 parts of colophony, 2 to 2·5 parts of stearine oil, until liquid, add 48 to 60 parts of finely powdered Vienna lime and let cool with stirring. This polish should be kept in well closed cans.

An Excellent Cement for Porcelain and Stoneware is said to be obtained in the following manner according to a French receipt. Mix 20 grammes of fish glue with an equal weight of crystallizable acetic acid and evaporate the mixture carefully to a sirupy consistency so that it forms a gelatinous mass on cooling. For use the cement thus obtained is made liquid again by heating and applied to the fracture with a brush. The pieces should now be pressed firmly together, by winding a twine tightly around them, until the cement has hardened.—Centralblatt für Glasindustrie und Keramik.

Glass-like Plates which are impervious to acids, salts and alkalies, flexible, odorless and infrangible, and still possess a transparency similar to ordinary glass, are said to be obtained by dissolving 4 to 8 per cent. of collodion wool (soluble pyroxylin) in 1 per cent. of ether or alcohol and mixing the solution with 2 to 4 per cent. of castor oil or a similar non-resinifying oil and with 4 to 6 per cent. of Canada balsam. The inflammability of these plates is claimed to be much less than with others of collodion, and may be almost entirely obviated by admixture of magnesium chloride. An addition of zinc white produces the appearance of ivory.—Maschinen Constructeur.

Lanolin, Vaselin Pomade.—

Magnolia.—Lanolin, 1·5 kilo; white vaselin, 1·5 kilo; rose pomade, 500 grammes; orange flowers pomade, 250 grammes; tuberose pomade, 125 grammes; violet pomade, 125 grammes; bitter almond oil, 10 drops; and lemon peel oil, 5 drops.

Moss rose:—Lanolin, 1·5 kilo; white vaselin, 1·5 kilo; rose pomade, 610 grammes; orange flowers pomade, 310 grammes; tincture of aubergris, 40 grammes; tincture of musk, 30 grammes; and German rose oil, 10 grammes.

White lilac.—Lanolin, 1·5 kilo; white vaselin, 1·5 kilo; jasmine pomade, 700 grammes; tuberose pomade, 174 grammes; rose pomade, 100 grammes; muguet, 30 grammes; ylang-ylang oil, 5 grammes; and heliotropin crystallized, 1 gramme.

Wild rose.—Lanolin, 1·5 kilo; white vaselin, 1 5 kilo; rose pomade, 756 grammes; orange flowers pomade, 120 grammes; acacia pomade, 120 grammes; neroli oil, 2 grammes; and lemon oil, 2 grammes. Coloring, pink.

Ylang-ylang.—Lanolin, 1·5 kilo; white vaselin, 1·5 kilo; violet pomade, 485 grammes; rose pomade, 200 grammes; tuberose pomade, 100 grammes; jasmine pomade, 100 grammes; acacia pomade, 100 grammes; and ylang-ylang oil, 15 grammes. Coloring, pale yellow. —Wiener Drogisten Zeitung.

Electrolytic Purification of Glycerin.—Crude glycerin contains various salts of sodium and of potassium. It is treated with the usual reagents in such a manner that those salts are obtained by substitution which are the easiest to electrify. The anode is formed by cylinders or plates of carbon, a metal, a sulphide or another metallic compound, according to the kind of salt to be separated. The cathode consists of a quicksilver layer. A current of such strength as to decompose the salts without attacking the water and the glycerin is sent through the electrolyte. The alkali dissolves in the mercury, while the negative electric constituent of the decomposed salt is separated or enters into combinations which finally admit it to precipitate. Thus, chloride separates from the chlorides on the anode; with the sulphates the sulphuric acid set free is neutralized by a base in the vat which furnishes insoluble salts or combines with the metal of the anode, which is chosen in such a manner that sulphates result, which can be readily precipitated by a treatment at the end of the operation. When the mercury is saturated, it is regenerated by washing with water or distillation. After the treatment the glycerin is freed from its impurities in general. Sometimes it contains still other salts, which can, however, be readily removed, since they form insoluble deposits with lime, barytes or other bases.—Chemiker Zeitung.

Prevention of Boiler Scale.—In order to prevent the formation of boiler scale, a process is described which is employed considerably of late and consists in the use of chromates.

The lime contained in the feed water either as bicarbonate or as sulphate is precipitated in the shape of a light mud, but the walls of the boiler remain perfectly bright without being attacked in any manner. While under ordinary atmospheric pressure calcium chromate in solution is precipitated out by soda or Glauber's salt as calcium carbonate or as calcium sulphate; the latter is separated under higher pressure by chromates as calcium chromate. An excess of chromates or chromic acid does not exercise any deleterious action upon the metal, nor upon the materials used for packing. Experiments conducted before the addition of chromates to the feed water revealed after a period of two months a layer 10 to 12 mm. thick of very hard scale in the boiler, which was very difficult to remove and consisted of gypsum and lime subcarbonate. Upon employment of chromate, however, which is best employed as alkaline chromate in slight excess, only a thin slime was found after a four to five weeks' working period, which was already expelled by the exhaustion of the steam. The boiler itself was perfectly bright, and the walls were not attacked or corroded in the least. By the slight admixture of chromates, two pounds are sufficient for a small boiler for weeks; no injurious ingredients are carried in by the wet steam, the injection water, on the contrary, having been found to be chemically pure.—Allgemeine Brauer und Hopfen Zeitung.

SELECTED FORMULÆ.

Harness Oil.—

Neatsfoot oil	10 ounces.
Oil of turpentine	2 "
Petrolatum	4 "
Lampblack	½ "

Mix the lampblack with the turpentine, and the neatsfoot oil, melt the petrolatum and mix by shaking together.

Liquid Glue.—

1. Glue	200 parts.
Diluted acetic acid	400 "
Dissolve by the aid of heat and add—	
Alcohol	25 "
Alum	5 "
2. Glue	5 parts.
Calcium chloride	1 "
Water	1 "

Removal of Warts.—Wydol (Journ. de Med. de Paris) says that if green soap is spread on flannel and applied to warts for some fourteen days, they then become so soft that they can be easily removed.

To Clean Wall Paper.—Four ounces of pumice stone in fine powder are thoroughly mixed with 1 quart of flour and the mass is kneaded with water enough to form a thick dough. This dough is formed into rolls about 2 inches in diameter and 6 or 8 inches long; each one is sewed up in a piece of cotton cloth, and then boiled in water for from 40 to 50 minutes—long enough to render the dough firm. After cooling and allowing the rolls to stand for several hours, the outer portion is peeled off, and they are then ready for use, the paper being rubbed with them as in the bread process.

To Remove Pyro Stains from the Fingers.—Make a strong solution of chlorinated lime; dip the fingers which are stained in this, and rub the stains with a large crystal of citric acid. Apply the lime solution and acid alternately until the stain is removed; then rinse with water.

Shampoo Jelly.—

White castile soap	4 ounces.
Potassium carbonate	1 "
Water	6 "
Glycerin	2 "
Oil of lavender	5 drops.
Oil of bergamot	10 "

Shave the soap to ribbons, melt with the water on a water-bath, adding the carbonate; allow to become nearly cold and then stir in the remaining ingredients, with more water if required. The proportion of carbonate may be diminished if a less active preparation is preferred.

Impervious Corks.—Corks which have been steeped in petrolatum are said to be an excellent substitute for glass stoppers. Acid in no way affects them and chemical fumes do not cause decay in them, neither do they become fixed by a blow or long disuse.

Ink for Writing on Glass.—

Shellac	30 parts.
Alcohol	150 "
Borax	35 "
Water	250 "
Water-soluble dye, sufficient to color.	

Dissolve the shellac in the alcohol, the borax in the water and pour the shellac solution slowly into that of the borax. Then add the coloring matter previously dissolved in a little water.

To Bleach Ivory.—

1. Expose the ivory for three or four days to the action of sunlight, in a bath of turpentine oil.

2. Treat the ivory alternately with a solution of potassium permanganate (1 in 250) and oxalic acid (1 in 100), letting the ivory remain in each solution for a half hour; then rinse well with water, and repeat the process a number of times.

3. Place the ivory in a hot mixture of undissolved lime, bran and water; remove after a short interval, place in dry sawdust, and with the latter rub thoroughly; then expose to the air.

Floor Polish.—

Potash	1 part.
Water	4 "
Yellow beeswax	5 "
Hot water, a sufficient quantity.	

Emulsify the wax by boiling it in the water in which the potash has been dissolved; stir the whole time. The exact amount of boiling is determined by the absence of any free water in the mass. Then remove the vessel from the fire, and gently pour in a little boiling water, and stir the mixture carefully. If a fat-like mass appears without traces of watery particles, one may know the mass is in a fit condition to be liquefied by the addition of more hot water without the water separating. Then put in the water to the extent of 200 to 225 parts, and re-heat the compound for five to ten minutes, without allowing it to reach the boiling point. Stir constantly until the mixture is cool, so as to prevent the separation of the wax, when a cream-like mass results, which gives a quick and brilliant polish on woodwork, if applied in the usual way, on a piece of flannel rag, and polished by rubbing with another piece of flannel.—Druggists' Circular.

Cleansing Fluids.—A new spot-remover, or cleansing fluid, which, it is claimed, is of extraordinary value, is made as follows:

1. Saponin	7 parts.
Water	130 "
Alcohol	70 "
Benzin	1788 "
Oil mirbane	5 "
2. Benzene (benzol)	80 "
Acetic ether	10 "
Pear oil	1 "

This yields an effective grease eradicator, of an agreeable odor.—Bulletin of Pharmacy.

COMBINATION OF NITROGEN WITH OXYGEN.*

IN purifying nitrogen from argon, which formed the mixture which I had at my disposal in the proportion of thirty hundredths, I measured the proportion between the nitrogen and the oxygen combined slowly under the influence of the electric effluvium and then absorbed by the potassa. This proportion merits some attention with reference to the gradual and successive formation of the different oxides of nitrogen, a question which I have considered several times in the course of my thermo-chemical studies.

I operated with large eprouvettes containing 250 c. c. to 300 c. c. over mercury. The sparks flashed between two long platinum wires, each carried through a double bent glass tube, open at both ends and filled with mercury, according to the arrangement I described in my work on Chemical Mechanics (II., p. 340). This disposition allowed of operating without wires soldered in the glass, and of varying the explosive distance at pleasure. The platinum came freely from both parts of the glass tube.

Impure argon, having a little larger proportion of oxygen, was mixed with double the volume of nitrogen, under the impression that nitrogen peroxide would be formed—

$$Az + O^2 = Az\,O^2.$$

After the introduction of the gaseous mixture in the eprouvette, the glass tubes were stopped in; then the platinum wires in the tubes; finally, by means of a bent pipette, 20 cm. to 30 cm. of a nearly saturated solution of potassa was added.

The tension of the watery vapor contained within the gases in these conditions is extremely feeble.

The distance in the eprouvette between the liquid layer of potassa and the upper space where the sparks flashed was about 15 cm.

The platinum wires were then brought in contact with a strong induction coil, fed by a current of a tension of 12·6 volts.

By stopping the wires parallely and at a suitable distance, and by regulating the vibratory interrupter, there flashed between the two wires a continual flow of sparks over a length of from 10 mm. to 15 mm. in the form of a very brilliant violet ribbon. For a certain period of the interruption the flow of electricity even became so active that the wires reddened, and the luminous violet ribbon was transformed into a continuous red flame.

It is convenient to anticipate this phenomenon. It is also indispensable to prevent the sparks from touching the glass of the eprouvette, which they might heat, decompose and rupture.

Under the conditions I have described, there appears in the gases a trace of nitrous vapor. This vapor is diffused rapidly in consequence of the violent agitation of the gases by the flow of sparks and is dissolved in the potassa situated below, forming in it a mixture of azotite and azotate.

At this point I have noticed an interesting circumstance. When the whole of the nitrogen has been absorbed, on measuring the proportion of oxygen remaining mixed with the argon, I found that this proportion was quite below that which corresponded with nitrogen peroxide. In a first experiment the proportion between the nitrogen and oxygen combined was:

$$Az : O = 1{\cdot}65.$$

In a second experiment it was:

$$Az : O = 1{\cdot}84$$

instead of 2·0.

Now, according to the last proportion, the nitrous and nitric acids, or more exactly the potassium azotite and azotate, ought to be produced in equal equivalents.†

$$2\,Az\,O^2 + 2\,KOH = Az\,O^2\,K + Az\,O^3\,K + H^2\,O;$$

while the experiments have indicated in the two cases an excess of nitrous acid.

It appears from this circumstance that gaseous nitric acid is formed at first, even in presence of an excess of oxygen, and that it does not change into nitrogen peroxide except by a slower action, so slow that the nitrous gas under very feeble tension has the time to be diffused through a gaseous column of from 0·10 m. to 0·15 m., and to reach the potassa, which fixes it in the form of azotite before the oxygen in excess in this column changes it into peroxide.

In a word, the nitrogen bioxide, formed under the action of the spark on the mixture of nitrogen, argon and oxygen, combines with a first atom of oxygen to form nitrous acid—

$$2\,Az\,O + O = Az^2\,O^3$$

before uniting with a second atom of oxygen to form nitrogen peroxide—

$$Az^2\,O^3 + O = 2\,Az\,O^2.$$

I have already remarked this circumstance in considering directly the action of nitrogen bioxide on oxygen. When the nitrogen bioxide is introduced, bubble by bubble, into an atmosphere of oxygen in presence of a concentrated solution of potassa, or even of baryta, under a large surface and in constant agitation, there is formed scarcely more than potassium azotite; for example, 96 to 98 per cent. of the proportion equivalent to nitrogen bioxide. The present experiments furnish a new confirmation of the succession of the two formations, whether proceeding with free nitrogen or nitrogen bioxide.

To avoid all confusion, I observe, also, that if there is no potassium or agent capable of absorbing the nitrous acid, the complete combination of the oxygen and the nitrogen bioxide is effected in a space of time

*From the French of M. Berthelot, in the Annales de Chimie et de Physique.

†It was a Frenchman (Lavoisier) who first applied the term azote to the principal constituent of the air, and while the French have followed the Germans, English and other nations in superseding the name with the term nitrogen and the corresponding forms for the acids, nitric, nitrous, they still adhere to the symbol Az, and to the corresponding forms for the salts, azotate, azotite, even side by side with the other forms. The prefix azo is also still used largely, and in some cases exclusively, in English, and is familiar to every chemical student. It is, therefore, the practice of the translator not to interfere with the French forms in the case of nitrogen and its compounds, especially as an attempt to change the symbol in the formulæ, so freely made use of by the French, would be exceedingly liable to lead to error in transcription by amanuensis, and sometimes, for consistency, might require other changes.

so short that the first of the two reactions passes unperceived in the calorimeters.

The fact should likewise be borne in mind that, in presence of water in large excess, the nitrogen peroxide is changed into nitric acid and bioxide; while, if the proportion of water is not considerable, a mixture of nitric and nitrous acids is obtained. The latter afterward absorbs the oxygen slowly, and is finally converted into nitric acid. From this we see that circumstances apparently slight may cause a considerable variation in the combination of nitrogen and its compounds with oxygen.

THE PALACES OF NATIONS AT THE PARIS EXPOSITION.

THE visitor to the Paris Exposition, after he has taken a general survey of the grounds, is very apt to wander into the pavilions of the various countries which form the "Street of Nations." These buildings occupy the left bank of the Seine. The first building which is encountered is the Pavilion of Italy, whose large gilded domes suggest to such a remarkable degree San Marco at Venice; the style is Venetian Gothic of the sixteenth century, and the architect has embraced in it some of the most beautiful bits of the Doge's Palace at Venice. Ogival architecture is rare in Italy, but it has always been celebrated among artists on account of its beauty. The center of the building is crowned by a large dome and each of the two wings has a smaller dome. The façades are elaborately ornamented with statues and mosaics. The interior which has a gallery is largely given up to exhibition purposes. Some of the most important objects of the exhibition are furnished by the manufacturers of Italy, especial attention being paid to the art industries for which Italy is so famous. The chandeliers with their crystal lusters are specially noticeable. The Palace of Italy was called by the workmen who were helping to construct the various buildings "The Cathedral."

The Palace of Denmark forms part of a series of buildings of the second rank which are installed among the trees of Quai d'Orsay. This building owes its existence to public subscription, which was opened by the newspapers of the country. The construction is original and represents a farm house in Jutland. The front with its carved wood is very attractive. The interior is fitted up like the Danish villa.—For our engravings we are indebted to Le Monde Illustré.

THE PARIS EXPOSITION—THE PAVILION OF ITALY.

THE ELECTRIC AUTOMOBILE.*

By A. L. RIKER.

IN presenting this paper on the electric automobile for your consideration and discussion to-night, I will endeavor to clear up a few of the mysteries surrounding this type of vehicle, and demonstrate the advantages it possesses over all other forms of motor vehicles. In purchasing a vehicle—an automobile—for pleasure driving, one is naturally anxious to procure a vehicle that will require the least possible attention from the operator, which condition is met alone by the electric automobile. This may seem to be a very positive statement, but I shall prove it to be correct. To begin with, we must have a basis of comparison, and for this we must turn to that most widely used and popular method of vehicle propulsion, the hay motor, commonly known as the horse. My reasons for referring to him are as follows:

You are all probably more familiar with this "motor" than any other and know how he automatically overcomes changes in his work. For instance, driving along a road, and arriving at the foot of a hill, your horse puts forth the extra effort necessary to accomplish the additional work without any attention on your part, and this is true only of the horse and the electric motor. All other motors require some manipulation, however slight, on the part of the operator. Another feature that they possess in common is the ability to exert the greatest traction effort at the lowest speed. Again, the fact that you can greatly overload them both for short periods, is common only to these two powers.

Under these conditions we do not require any changes of gearing in the electric automobile to alter the speed or to climb a grade, but accomplish this electrically by a series of switches, so grouped as to be operated by one handle, and which I shall designate hereafter as the controller. From this controller wires lead to four groups of batteries, and to the motor or motors as the case may be. At this point I will state that there are a number of different arrangements for varying the speed of electric automobiles, but I think that this one is the best, and most commonly used, and a description of this method of speed regulation will be of more interest and value to you. As the speed of an electric motor depends upon the pressure of the current supplied, you will at once see that change of pressure means also change of speed. This pressure, in technical language, is called voltage.

As it is necessary when re-charging the batteries to connect them to a direct current, each cell requiring about 2·5 volts, and as the prevailing pressure is in the neighborhood of 110 volts, it is necessary, if we desire to charge economically, to use from 40 to 44 cells of battery. These are placed in four crates or boxes, each holding ten cells. The cells in each crate are connected in series, that is to say, the positive terminal of one is fastened to the negative terminal of the next. As the pressure of a cell on this charge is about two volts, and there are ten in a crate, the pressure at the terminals of each crate is approximately 20 volts. Now it is possible to so connect the four boxes that we obtain three pressures, namely, 20 volts, 40 volts and 80 volts.

The controller changes the connections of the four sets of crates, and enables the various pressures to be supplied to the motor. In the first position the four crates are connected so that the motor receives a pressure of 20 volts. As they are now connected in multiple, each crate furnishes one-fourth the total current; for example, if the motor takes 20 amperes, each box is furnishing five. This arrangement allows all of the cells to discharge at the same time. This method of control has another very advantageous feature. If one of the crates should show signs of being discharged before the others, by leaving the controller in the first position for a short time, the other crates will charge the weak one, and save those cells from over-discharge and possible injury.

* A paper read at the 204th meeting of the New York Electrical Society, New York city, March 22, 1900.

In the second position of the controller, the crates numbers 1 and 2 are connected in series, as are also crates 3 and 4. These two sets are then grouped in multiple and furnish a pressure of 40 volts to the motor. In this second arrangement only one-half of the total current is supplied from each crate; therefore if the discharge is as before, 20 amperes, each crate or box is furnishing ten. In the third position we have the greatest pressure we are able to produce. In this position all the crates are connected in series, and the pressure supplied to the motor is 80 volts, and the total current of 20 amperes is furnished by each crate.

You see that by the above combinations we are able to produce three pressures, which correspond to three different speeds of the carriage. Of course, it is possible to increase the number of speeds by using more than four crates. For instance, six crates will give four speeds. But experience has shown that three speeds are sufficient and have been adopted as a standard arrangement for electric vehicles. These speeds are about as follows: First position, from 0 to 3½ miles per hour; second, from 3½ to 7 miles per hour; third, from 7 to 14 miles per hour. It is also possible to have these three speeds for backing, but practice has shown that two are sufficient.

I now show you the complete controller and the lever for operating it. When you remember that the forward and reverse speeds, as well as the shutting off of the supply of power to the motor, are all done by this one lever, you can see how easy it is to operate an electric carriage. For instance, you take your seat, placing one hand on the steering bar and the other upon the controlling lever. The most natural thing to do is to push the lever in the direction you wish to go. If you desire to go ahead, the lever is pushed in that direction, and the carriage immediately responds, without jerk, jar or noise. Wishing to increase the speed, you push the handle further and the carriage responds. When you wish to stop, what more natural than to pull the lever back and apply the brake. Now, you may wish to back your vehicle. By pressure of your thumb, you release a catch that prevents accidental reversal and pull the handle back. The carriage immediately goes backward. Nothing could be more simple or easier to operate, and I think that in this you will agree with me.

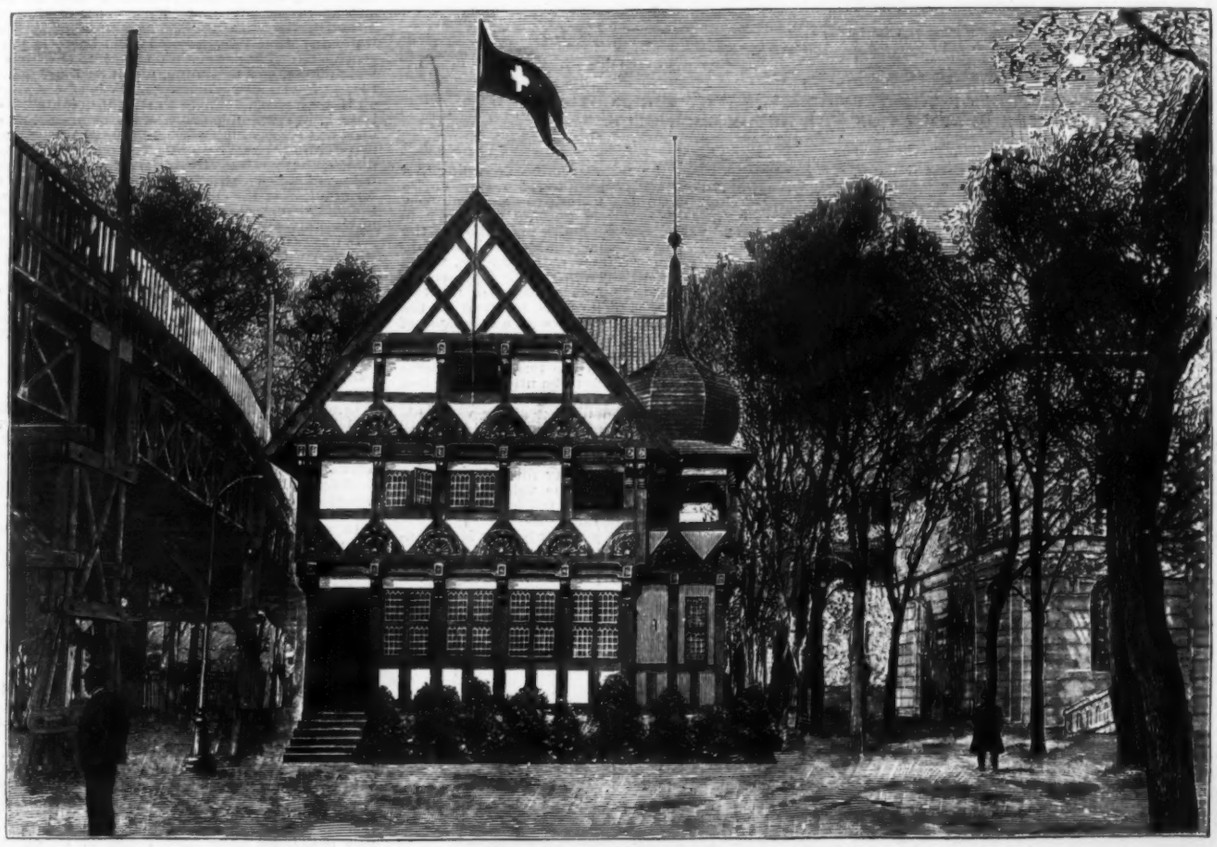
As it is necessary to know how much electricity we have stored up, and how fast this is being consumed, we use a combined volt and ampere meter. I think at this point it would be well to explain that the difference in pressure between a fully charged storage cell and the same discharged is about three-tenths of a volt, being two volts at the beginning and 1·7 volts at the end of the discharge. With 40 cells, the pressure at the start is 80 volts, which falls gradually to 68 at the finish. These meters are therefore marked in this manner—opposite 80 volts the word charged is written, and discharged against 68. You can therefore spin along at ease until, while running on a level stretch of road at a normal discharge, your meter reads 75 volts. You know then that you have used half your charge, and that you must either return or find some means of recharging. This device has been in constant use for over three years, and I have never known any one to run out of a charge if they went by the reading of the meter. I have so far explained only one side of the meter, and how it operates on discharge or the running of the carriage. It has still another function. When a storage battery is connected to a source of current to be recharged, the back pressure of a cell is about 2·1 volts, making the 40 cells require 84 volts to recharge them. As they absorb the charge, their pressure gradually rises to 2·5 volts per cell, or 100 volts for the 40 cells, at which pressure the charging should be stopped, as the battery is full. The meter also indicates this condition. As it is also necessary to know at what rate to recharge the cells, the other half of the instrument is graded in amperes. This portion of the meter has a double scale, reading either the amount of current going into or out of the battery, enabling us to charge at the proper rate for the best results to the battery, and when running, shows the amount of power being used. It is therefore possible with an electric carriage and one of these meters to know at any time just what horse power you are developing.

As it is absolutely necessary in recharging a battery to connect the positive terminal of the battery to the positive charging wire, and the negative battery terminal to the negative wire, some means must be devised making it impossible to connect them incorrectly. This can be accomplished in a number of ways. The one that has been most generally adopted consists of two parts, the socket, which in practice is fastened to the carriage and the positive and negative battery wires being attached to the two rings, the outer of which is positive and the inner negative. Fitting this socket is the plug, which is connected by a flexible cable to the source of current for charging. This plug consists of two concentric tubes which encircle and make contact with the rings in the socket. You will therefore see that to recharge, it is only necessary to insert the plug in the socket, and close a switch, it being impossible to connect the charging wires incorrectly.

A crate of batteries, four of which constitute the equipment, are provided with handles, so that they can be easily removed from the vehicle, and making it possible, by having two sets of batteries, to keep the carriage in constant service. The wires from the controller connect to these crates and are clamped by the thumb-screws at the end of the crate, making it possible to take out an exhausted battery and replace it with a fresh one inside of five minutes. A motor, the apparatus that transforms electric into mechanical energy and propels the carriage, is probably the most perfect of any power transforming device, having an average efficiency of 80 per cent. and especially adapted to vehicle propulsion, exerting a continuous rotary effort, capable of being overloaded from 100 to 300 per cent., and responding to every call made upon it. Noiseless and without vibration, it is and always will be the ideal motor for automobiles.

As you all know, when turning a corner, one wheel of the carriage must travel faster than the other. This can be accomplished in several ways with the electric automobile. This is what is called the single motor running gear, and the differential action of the wheels is accomplished by the well known method of making the driving axle in two parts, each half being keyed to a wheel and connected to each other by a system of gears. This arrangement is generally used for light carriages. Here is an entirely different method of obtaining the same effect. In this arrangement, the differential and single motor is replaced by two motors, each directly geared to a driving wheel. The motors are so connected electrically that the same results are obtained as from the differential gear, that is, if one wheel and motor have to go faster than the other, it can do so. This double motor equipment is used mostly for the heavier types of vehicles. Having shown that the electric possesses advantages over all other types of vehicles, why is it that any others exist? It is for this reason, and this alone, that the radius of the electric vehicle at present is limited to about 30 miles. If we could increase this radius of action to 90 or 100 miles, what one of you would think for one moment of any other motor? Even the competitors of the electric vehicle admit that its advantages far outweigh its disadvantages. Now let us look at the latter from the standpoint of the gasoline or steam vehicle manufacturer. First, the limited radius of action; second, the excessive weight; thirdly, the short life of the batteries; and finally, the great cost per mile. To refute these statements I have facts which were compiled from actual data. In regard to the radius of action, I will say that there are on the market to-day electric vehicles capable of making 50 to 75 miles on each charge of the battery, and I have a report of a carriage in France that has covered 108 miles on a single charge. This carriage weighed complete about 2,200 pounds. Further, I believe that inside of six months a light electric vehicle will be produced, not exceeding 1,000 pounds in weight, that will be capable of carrying two passengers fifty miles on one charge. This disposes of the first two statements. The last two can be brought under one head, as in the cost per mile the life of the battery must be taken into consideration. It has been published by competitors of the electric carriage that the cost of operation was five cents per mile. This is delightfully vague, as they do not state whether this is simply the cost of current for recharging or if they include in their figure the depreciation of the batteries. However, they have certainly put their estimate at a remarkably high figure. To offset these erroneous statements, I will give you a few facts as to the cost of operating electric vehicles, which data is not theoretical, but compiled from actual running expenses of a pleasure carriage. The vehicle that I have reference to, and from which this data was obtained, has been in almost constant use since 1897. During this period it has covered over 20,000 miles. The cost for battery maintenance has been $150, or ¾ of a cent per mile. The current, as supplied with the regular Edison Company's rate of ten cents per horse power hour, adds 1¾ cents per mile, making the total cost 2½ cents actual as against the theoretical statement of the gasoline manufacturer, 5 cents per mile.

As these figures just given are based on the present weight and capacity of the storage battery, let us indulge in a little speculation as to what we could accomplish with a battery giving from two to three times the capacity per pound over those in use to-day. As the weight of the battery is about 40 per cent. of the total load carried, and we are designing a vehicle to carry two persons, we will assume that our carriage and its occupants will weigh 1,300 pounds complete. Of this total weight, 500 pounds will be in the batteries. Now, our normal speed will be 15 miles per hour. To drive our carriage at this rate requires two horse power, and as our battery has this capacity for 4·5 hours, it is plainly to be seen that we should be able to cover between sixty and seventy miles on one charge. These figures are based on good macadam roads, with practically no hills. The cost per mile to operate such a



THE PARIS EXPOSITION—THE PAVILION OF DENMARK.

carriage would be 1·5 cents with current at the regular Edison rates. I stated this as a suppositious case, but as I have before stated, I expect to see such a carriage in a very short time. I hardly think it necessary to enlarge upon the advantages of the electric automobile, but it is the only carriage that a lady can operate, and it also appeals more to our æsthetic taste than any other form of motor.

THE TERRACES OF THE AUTOMOBILE CLUB.

TERRACED roofs are by no means a novelty. In the south of France, in Italy, in Spain and in Oriental countries, houses are covered in this manner with success. A simple pavement of flagstones or tiles laid in a bed of mortar or cement suffices in these climates, since the terraces never have to undergo the action of frosts such as occur in northern countries. Beneath the terraces in Italian palaces we frequently see ceilings that have been decorated with fresco paintings for many years, and yet have never been injured by humidity due to infiltrations of water. In our climate the conditions are not the same, and so our architects rightly avoid the use of terraced roofs in planning their edifices.

The castle of St. Germain, rebuilt by Francis I., and the upper terraces of which were renovated by Louis XIV., offered a fine example of such roofs. Francis I., according to Félibien, intrusted the construction of his castle to the Italian architect Sébastien Serlio, who covered the entire edifice with stone terraces and ornamental balustrades, after the Italian manner. This mode of construction was not adapted to our destructive climate. The humidity of French winters and serious infiltrations had long before ruined the castle when, in 1862, M. Millet, the architect, was commissioned to make an entire restoration of it. In order to assure the solidity of the palace, M. Millet covered the old terraces of stone with a series of small sloping roofs protected with lead and provided with gutters.

This system has long been employed in Germany for both ordinary and luxurious habitations, and numerous applications of it may be seen at Eupen, Cologne, Coblentz, Mayence, etc. It is much employed, too, in Holland, Belgium and Switzerland. It is in France only that the system has remained almost unknown, and it was but a short time ago, after M. Eugene Pigneux obtained the right to exploit the German patent in France, that terraced roofing of volcanic cement obtained a foothold in our country and that our architects began to employ it.

The Automobile Club, recently installed on the Place de la Concorde, has seen fit to adopt this system in the beautiful structure in which it has its home; and the terraces constructed by M. Rives, the architect, perfectly fulfill the programme proposed by the members of the organization.

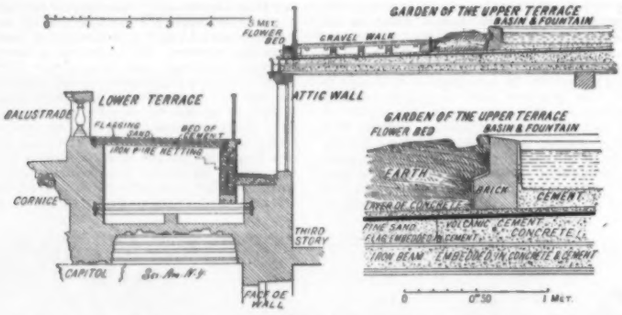


FIG. 1.—SECTION OF THE TERRACES FORMING THE ROOFING OF THE QUARTERS OF THE AUTOMOBILE CLUB.

In order to effect the reconstruction according to a new plan, M. Rives was obliged to remove the entire roof of the building. The terrace roofing, however, offered him the advantage of gaining one story in height without exceeding the limits permitted by the city regulations. He was thus enabled to install, directly beneath the upper terrace, a dining room, which is shown in the section given in Fig. 1. This section shows, too, the construction, as a whole, of the two floors of the new terrace. The place reserved for the sheets of volcanic cement covered with a thin layer of concrete may be seen in the details on a larger scale to the right of the engraving. This necessary facing is isolating and protective when the terrace is to serve only as a roofing. When it is to be utilized, and free access to it is to be had, as in the case under consideration, there may be arranged upon it either vegetable soil in which to plant shrubs or flowers, or light foundations of concrete for the establishment of a basin and fountain, etc.

Any rain or other water that may filter through the concrete facing will flow over the volcanic cement, which remains impermeable, and fall into the gutter arranged along the upper terrace.

At the Automobile Club, the upper terrace is a genuine hanging garden. The panorama that unfolds itself in the direction of Place de la Concorde is remarkable. The observer sees the Seine with the Champs Elysées and the gardens of the Tuileries, and Notre-Dame and the Pantheon, while the dome of the Invalides towering over the palaces of the Exposition of 1900 completes the admirable view of the capital.

FIG. 2.—GENERAL VIEW OF THE GARDEN.

M. Millet was not acquainted with the invention of M. Haensler, who, in 1838, devised an ingenious system of terraced roofing capable of perfectly resisting the inclemency of our climate. Such roofing may be constructed upon either a wooden or iron platform. Upon the external surface of the latter is laid a bed of concrete having a slope of from 0·03 to 0·05 cm. to the meter, and over this is spread a thin layer of fine sand. Upon the latter are laid four thicknesses of strong paper, which, manufactured especially for the purpose, possesses peculiar properties. These thicknesses of paper, cemented together by a hot solution of an elastic substance, remain both inalterable and impermeable. This composition, which is kept a secret, constitutes what is now called "terraced roofing of volcanic cement."

Fig. 2 gives a general view of the suspended garden with its beds of flowers, shrubbery and central basin. The stand in the background is designed for occupancy by musicians, whose duty it will be to make things cheerful for the members of the club, who during fine weather take their meals amid the shrubbery or under an awning erected to shelter them from the heat of the sun. The elevator is located beneath the musicians' stand.—La Nature.

APPLIED SCIENCE IN MUNICIPAL WORK.

THE city of Marshalltown, Iowa, has just issued in pamphlet form the "preliminary data for the design of a proposed sewage system," which illustrates in an unusually satisfactory manner the rare case in which municipal authorities have displayed enough of wisdom and of familiarity with the resources of their country to bring to bear upon their problems of construction the best scientific knowledge available. The committee of the city council applied to Prof. Marston, the civil engineer, Prof. Weems, the chemist, and Prof. Pammel, the botanist of the University of Iowa, for advice, and under their direction the data reported were collected. The work of the survey in detail was done by trained students, largely, and the drawings were made by Miss Wilson. The city of Marshalltown paid all expenses and its officials seem to have heartily seconded the endeavor of the chemists and engineers of the university.

The city has a population of 12,000 and is the county seat of Marshall County and the commercial center of a rich agricultural country. There is some manufacturing, the principal shops of the Iowa Central Railroad and large beet-sugar manufacturing establishments being located there. The sewer system contains about ten miles of sewers and laterals. Water is supplied from drive wells and to the amount of about 1,300,000 gallons per day, the glucose and packing houses taking a large fraction of that used for other than domestic purposes. It contains about 300 parts solid matter in the million, mainly lime and magnesia salts. Deeper wells of artesian character, belonging to the glucose company, show about 900 parts solid matter, of which about two-thirds seem to be lime and magnesia salts and 15 per cent. organic matter, although the wells are 300 feet in depth. The city water in May, 1899, showed 1,040 bacteria per cubic centimeter. The sewage is passed into the Iowa River, which flows, at a minimum, about 3,250,000 gallons per twenty-four hours, and contamination by sewage is at all times serious. Where thus contaminated, its color is dark, its odor offensive, and its mean content of bacteria at times as high as about 100,000 per cubic centimeter, and probably more. The outcome of litigation directed against the city by residents of the country below, along the banks of the stream, has been the determination of the city to adopt a system of purification of the sewage, and it is to this end that the experts of the university were consulted.

It was promptly discovered that the glucose sewage was very different from that of the city, in respect to content of bacteria, as was to have been expected. Its bacteria ranged up to, in one case, nearly 10,000,000 per cubic centimeter. While not unwholesome when fresh, it is subject to putrefaction of a seriously objectionable character. The packing house sewage also contains large quantities of bacteria and has a characteristic composition. The result of intermixture of these various kinds of sewage is a peculiarly offensive and troublesome compound.

In seeking the best remedy for this state of affairs at Marshalltown, the data printed in the report were gathered. The work included a study of the topography of the country, of the character of the soil, the available materials for construction, of filtering and settling tanks, and the cost of labor and material. It is stated that the works should be completed before November of the present year.

In the performance of the work of the consulting chemists and bacteriologists, the methods of the Massachusetts Board of Health were usually followed.—R. H. Thurston in Science.

ON THE DISCOVERY AND OCCURRENCE OF MINERALS CONTAINING RARE ELEMENTS.*

By Baron A. E. NORDENSKIÖLD.

THE first mineral referred to is scheelite, and the next cerite, which contains no less than four rare metals. The incandescent light produced when the latter mineral is fused with charcoal powder was first observed by Cronstedt in 1751. The discovery of glucina, lithia, selenium and yttria is next referred to. Minerals containing yttria and oxides related to it were, at one time, thought to be almost limited to certain pegmatite veins running in a broad zone on both sides of the sixtieth parallel of latitude. Latterly, fluocerite, orthite, and gadolinite have been found in Dalecarlia; and among these minerals Denedicks discovered a silicate of yttrium containing 1·5 per cent. of nitrogen and helium. The author discovered kainosite, a silico-carbonate of yttrium and calcium, among minerals from Hitterö; and the same mineral was subsequently discovered in the flucan, fissures, and drusy cavities at the Nordmarken mines. The last mentioned discovery and others related to it appear to suggest that the mode of formation of fissure-minerals is not so unlike that of the pegmatite-veins of the Primary rocks as is generally supposed.

Thorium, discovered by Berzelius in 1829, was originally obtained from the rich mineral locality of Langesund (called Brevig in mineralogical literature), but it has since been recorded from other localities, including Arendal and Finnish Lapland. It is now obtained from the monazite sand of rivers in the Brazils and South Carolina. Thorite contains about 0·5 per cent. of inactive gas, probably a mixture of nitrogen and helium; but the latter element was first obtained from the mineral clevite, also containing thorium, discovered by the author in 1877. Other minerals bearing nitrogen, argon, or helium are referred to; and under the head of minerals bearing tantalum, mention is made of Giesecke's discoveries in Greenland. Among these is fergusonite, one of the richest sources hitherto known for obtaining that mysterious gas, or mixture of gases, which on our planet seems to be almost exclusively confined to minerals containing rare earths. "The group of earths, as well as the group of gases, of which we are here speaking, might therefore be compared with certain genera among organic beings, whose species, having not yet fully differentiated, offer to the descriptive zoologist or botanist difficulties analogous to those with which chemists meet in endeavoring to separate the rare earths and rare gases."—From The Chemical News.

* Read before the Geological Society of London, April 4, 1900.

LIQUIDS UNDER HIGH PRESSURE.

IN connection with certain investigations at the West Virginia Agricultural Experiment Station, it was considered desirable to subject certain liquids to high pressures, and the following method and apparatus were devised for the purpose by Mr. B. H. Hite, the chemist of the station.

The liquid is placed in a lead tube which is closed with a lid of the same material, and placed in a steel cylinder, *C*, *C*, Fig. 1, just large enough to admit the tube, and the lower end of the cylinder is closed with a steel plug, *O*, the upper end with the piston, *P*. *B*

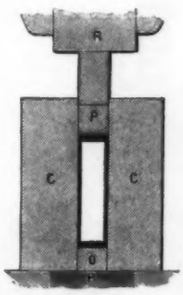


FIG. 1.

is the bed plate and *R* the ram of a hydraulic press, by means of which the pressure is applied to the lead tube, *L*, and its contents.

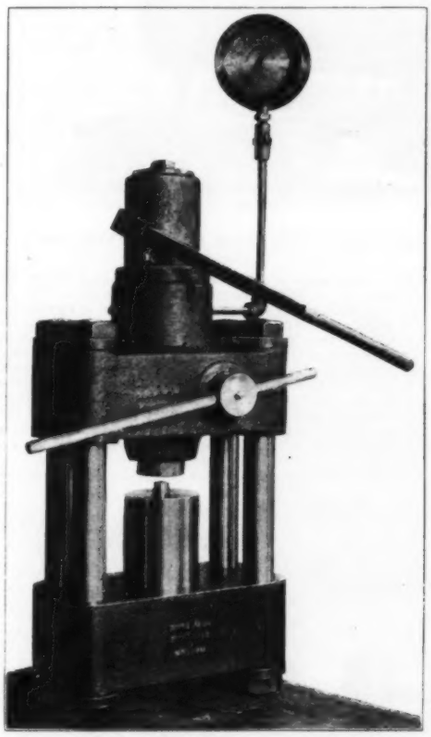
Most of the cylinders used were 7 inches long by 6 inches in diameter. The hole through the cylinders varied from 1⅛ inch to 1¼ inch in diameter. Some of the cylinders were "built up" of concentric pieces shrunk together, the object being to make the outer parts carry more of the strain. Whether this is accomplished, at least to any considerable extent, would be difficult to say. It was always the inner piece that gave way. Many of the best results were obtained with the cylinders made of one piece of special steel, which, without much tempering, was hard enough to keep its shape.

The plugs, *O*, and lower ends of the pistons, *P*, were made of soft steel, in order that they might more readily expand with the cylinder.

The pressure seals the lid on the lead tubes so that the liquid is completely incased in one continuous piece of metal, and the pressure to which it may be subjected is limited only by the strength of the cylinder.

Liquids are, by no means, practically incompressible when placed in this device; indeed, they behave like very strong, but perfectly elastic springs.

The compressibility of liquids under these high



HYDRAULIC PRESS.

pressures may be very accurately determined in the following manner:

The little piconometer bottle (shown in Fig. 2, and differing from an ordinary glass stoppered bottle only in that the top of the stopper is expanded into a little bowl or cup which, when the stopper is in position, communicates with the interior of the bottle by means of a very fine capillary hole through the stopper) is weighed accurately empty, then weighed full of mercury, which, of course, gives the weight of the volume of mercury required to fill the bottle. The mercury is then poured out and the bottle filled with the liquid whose compressibility is to be determined, the stopper inserted firmly, and a quantity of mercury poured into the cup. Although the mercury is heavier, of course, than the liquid in the bottle (e. g. water), the mercury cannot enter the bottle, because the water and mercury cannot pass each other in the capillary hole. Any difference in pressure, however, will allow either the mercury to flow into the bottle, or the water to flow out, depending upon whether the pressure is higher without or within.

The little bottle loaded in this way is placed in the lead tube, which is then filled up with water and subjected to pressure, as above set forth, when just enough mercury will enter the bottle (and fall to the bottom) to make up for the contraction experienced by the water in the bottle under the pressure applied.

FIG. 2.

On removing the pressure a corresponding quantity of water will be forced out through the stopper, but this does not matter, as everything is estimated in terms of the mercury, which is then poured out, dried and weighed, and from the weight of this quantity of mercury and the quantity required to fill the bottle, the compressibility of the water is estimated. This, of course, neglects the compressibility of the small quantity of mercury which has found its way into the bottle while the pressure was being applied; but this can be estimated in a special determination.

In this way the compressibility of many liquids at various temperatures and pressures has been determined. The compressibility (in round numbers) of the following well known liquids, at ordinary temperatures and 100,000 pounds pressure to the square inch, will serve as examples:

Water	14 per cent.
Benzene	16 "
Alcohol, carbon bisulphide, and chloroform	18 "
Ether	26 "
Mercury, less than	1 "

Having determined accurately the compressibility of some liquid—preferably water—throughout a sufficient range of pressures, this method can be used to determine the pressure on the liquids in the hydraulic machinery, etc.

The accuracy of pressure gages necessarily depends upon the elasticity of some material. Those in general use depend upon the elasticity of some solid. Solids are never perfectly elastic, even when subjected to relatively small strains, and the change in form which they experience as a result of the pressure must be greatly magnified in order to make the gages in which they are used sufficiently delicate, and even then such gages have but a very limited range.

The accuracy of this proposed gage depends solely upon the elasticity of the water and mercury and the accuracy of the balance used in the weighings; but water is perfectly elastic, and few instruments are more accurate than the analytical balance. The delicacy of this gage depends, of course, upon the weight of the quantity of mercury that enters the bottle under the pressure applied; but this quantity depends upon the size of the bottle, which can be varied at will.

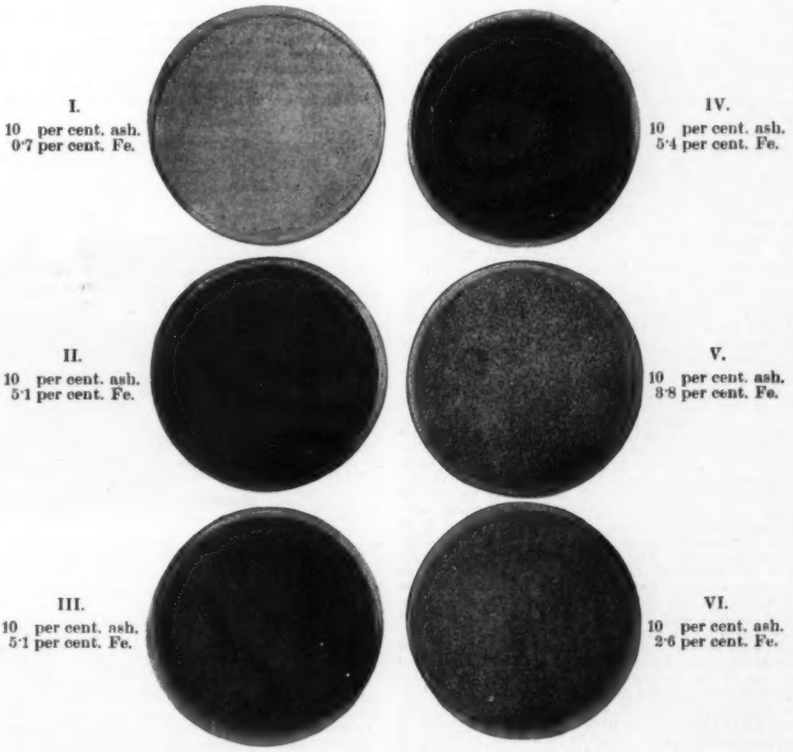
Under a pressure of 100,000 pounds per square inch, the weight of mercury that enters the bottle is just about twice the weight of the water required to fill the bottle, so, in working with a bottle that would hold 30 grammes (about 1 ounce) of water, 60 grammes of mercury would enter the bottle under the pressure named. This quantity can be weighed with ease to 0·0001 gramme, giving 600,000 units for the 100,000 pounds, or six units to the pound. So this method of measuring hydraulic pressures should enable us to detect a difference of about 1 pound throughout a range of pressures that appears to be limited only by the crushing strength of steel.

EXAMINATION OF COAL BY ROENTGEN RAYS.

EXPERIMENTS have been made in Germany for the purpose of ascertaining the practical value of the Roentgen rays in determining the quantity of ash yielded by various fuels. These experiments have proven that the method does not give the same results even for coal taken from the same vein. It was, therefore, inferred that the argillaceous earth associated with the coal is readily penetrated by the rays, and that the small quantity of the oxides of the heavy metals excluded the rays.

Herr F. Kotte has investigated the method systematically and published his conclusions in Stahl und Eisen.

Pieces of the best obtainable coal were so finely pulverized in a mortar that the powder could be passed through a brass screen with 22 × 27 meshes per square centimeter. A sample of this powder was burnt; the quantity of ash obtained was 1·66 per cent.



EXAMINATION OF COAL BY MEANS OF ROENTGEN RAYS.

Six different specimens of minerals were then pulverized and sifted through the same screen. Of these powders, the experimenter very carefully determined the solid residue and the quantity of iron which they contained. The experiments with these six samples gave the following results:

1. Gray argillite, 93·14 per cent. residue, 0·79 per cent. iron.

2. Blackband, 43·26 per cent. residue, 25·25 per cent. iron.

3. Blackband, 65·5 per cent. residue, 39·03 per cent. iron.

4. Blackband, 56·36 per cent. residue, 39·03 per cent. iron.

5. Ferruginous carbonaceous argillite, 43·84 per cent. residue, 19 per cent. iron.

6. Ferruginous carbonaceous argillite, 44·29 per cent. residue, 13·45 per cent. iron.

With the pure coal powder originally produced and the powdered minerals, six mixtures were made, all of which contained 10 per cent. ash. As a check, three of these powders were again tested to determine whether the proportions of the mixture were correct. Small pasteboard boxes, 1 mm. deep, were then filled to the edge with the powders, placed on a photographic plate, and subjected to the action of the Roentgen rays. The distance between the plate and the source of light was 25 centimeters; the time of exposure, 3 minutes.

The picture obtained is herewith reproduced. It

shows very great differences in the several images, although all six specimens contained the same quantity of ash. These differences correspond with the various quantities of iron contained in the specimens, as the following table shows:

Specimen.	I.	II.	III.	IV.	V.	VI.
	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.
Total quantity of ash contained.	10	10	10	10	10	10
Total quantity of iron contained.	0·07	5·1	5·1	5·4	3·8	2·6

Specimen I., containing the smallest amount of iron, gave the brightest image; specimen IV., containing the greatest quantity of iron, gave the darkest image.

Interesting as these experiments are, they demonstrate that the Roentgen rays cannot be used in accurately determining the ash of coal.

[Continued from SUPPLEMENT, No. 1276, page 20451.]

AN OUTLINE OF THE DEVELOPMENT OF AMERICAN LOCOMOTIVES.—III.

SINCE the advent of the class K locomotive No. 11, described in the previous issue, in which the possibility of a great extension of power was demoustrated, the size of the road locomotive has been steadily increased. The demand for heavier engines and higher speeds came the instant that it was found that they could be obtained, with the result that the machines of to-day dwarf their predecessors into insignificance. The drawings now skip over a period of fifteen years, and the balance of the series is devoted to the illustrating of the modern road engines designed for passenger and freight service.

No. 12 illustrates a modern high-speed express passenger locomotive of what is known as the Atlantic type, dating from 1896 and taking its name from the fact that it was first used on the run between Camden and Atlantic City. There are embodied in it a number of important modifications from the standard eight-wheeled express passenger locomotive. Both driving axles are placed in front of the firebox. This is done in order to obtain a greater depth of firebox than is possible where one or more of the axles is beneath it. The arrangement necessarily places the front driving axle very close to the rear end of the guides, so that the back pair of driving wheels carry the main crank-pin in order to obtain a sufficient length of the connecting rod. With the firebox entirely back of the rear driving axle the overhang is too great to be carried by the driving wheel springs, and so a pair of auxiliary trailing wheels is placed beneath the firebox to sustain its weight. This arrangement secures the desired distribution of the weight on the several wheels of the machine. The design is exceedingly compact and is especially adapted for running at very high speeds. This work is facilitated by the very short side rod due to the contracted rigid wheel base, as a whole, that is brought about by the use of the bogie truck at the front and the trailing wheels at the rear. These engines have been built with boilers adapted for the burning of both bituminous and anthracite coal.

This engine, with the ordinary American type of eight-wheeled engine and the ten-wheeler, are now doing practically all of the passenger service of the country. The modern high-speed express passenger locomotive of the eight-wheeled American type is shown in No. 13. This engine follows in the lead of the class K, and we find the boiler set very high above the rails and with the firebox on the top of the frames. The latter is of the Belpaire type and extends well back into the cab. In this type there is a small auxiliary dome above the firebox to which the safety valves are attached. The main dome is covered by a plain casting without ornamentation. The regular dome is in front of this, beyond which is the sand box of similar outside appearance. The air brake applies the shoes to all of the wheels of the engine, the truck as well as the driving wheels. Cast steel takes the place of cast iron for many of the parts, such as driving wheel centers and the like, and great care is taken to lighten all moving parts to as great an extent as may be consistent with safety from breakage. The guides are protected by a shield that excludes dust and dirt. The valves are of the balanced type and can be readily handled by the ordinary reverse lever which is used.

The engine is evidently a large and powerful one, and yet all of the working parts have an appearance of lightness and grace that is not to be found in those of earlier design. This is due to the extensive use of cast steel for the parts previously made of cast iron, and is particularly noticeable in the driving wheels. A better distribution of material has also been obtained by the use of an I section for the side and connecting rods, a practice that was initiated in the early seventies and which has now become universal.

With the growth in the size of the boiler has also come an increase in the steam pressure carried until that of the engine shown as No. 13 is placed at 185 pounds per square inch. Raising the center of the boiler so high above the rails has enabled the designer to increase its diameter to 4 feet 11 inches, which, with 310 tubes and a firebox measuring 3 feet 4 inches by 9 feet 11⅝ inches, secures a heating surface of 1,750 square feet and a grate area of 33 square feet. This gives an enormous steaming capacity in comparison with the earlier engines, so that the diameter of the cylinders has been increased to 18½ inches with a piston stroke of 26 inches. The driving wheels are but 2 inches larger in diameter than those of the class K and are 80 inches.

The total weight of this engine in working order is 134,569 pounds, of which 93,100 pounds are upon the driving wheels, giving a high tractive power, but one that is no more than sufficient to meet the great demands that are made upon it.

The last passenger locomotive to be illustrated is No. 14, which is of the ten-wheeled type and is one of the latest designs.

This is a very powerful locomotive and is among the heaviest in passenger service in the country. With cylinders 20 inches in diameter, a piston stroke of 28 inches, a steam pressure of 210 pounds per square inch, and 80 inch driving wheels, it is capable of hauling fourteen passenger cars at a speed of 60 miles an hour. It is not designed to make phenomenal speeds, but simply to haul the heaviest trains at present schedules.

The ten-wheeled type is used where it is desired to put more weight into the boiler than is permissible with the eight-wheeled type or mogul, and the upper limit of total weight is not specified.

The boiler is large. It is of the extended wagon top, radial stay type, with the firebox over the frames. The diameter of the front end of the shell is 66 inches, and at the throat 74 inches. There is ample room at the back end of the tubes for water space and circulation, the boiler being unusually wide at the throat. The height of the center of the boiler above the rails is 9 feet 2 inches. The heating surface is 2,917 square feet, and the length of the tubes is 15 feet.

Cast steel is used to a great extent to save weight. This material is used for driving wheel centers, pistons, crossheads, equalizers, and fulcrums in connection with the under-hung spring rigging, and in many other places where strength and a saving of weight are to be combined.

The large driving wheels necessitate a long wheel base, which is 16 feet 6 inches, the engine as a whole being 41 feet 4½ inches long. The cab has a full deck, making a comfortable arrangement for the men.

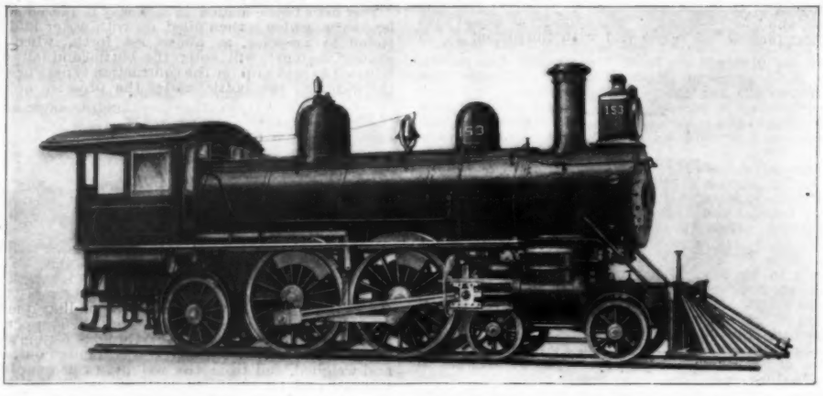
With these increases in dimensions, the total weight of the engine has correspondingly risen despite the fact that steel castings have been so liberally used. In working order, this engine weighs 171,800 pounds, of which 133,000 pounds are upon the driving wheels. All of this contributes to the power of the engine, and yet, despite its size, the appearance is far from being cumbersome or heavy.

We now come to the road engines that are used for the hauling of freight and which form, by far, the larger number of locomotives in service. First is the "Mogul" type, No. 15. It is used almost exclusively for freight service, although engines of this class are sometimes used to haul passenger trains. The distinguishing feature of the type is found in the arrangement of the wheels. This arrangement consists in using three pairs of driving wheels and a single pair of truck wheels in front.

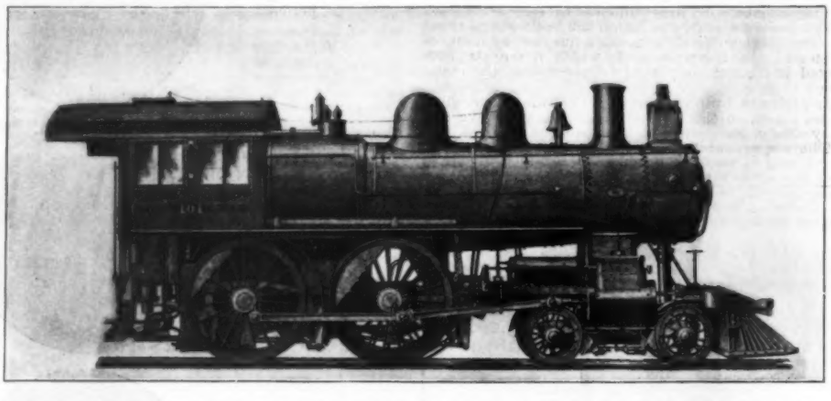
The engines of which the drawing is an illustration have cylinders 20 inches in diameter with a piston stroke of 28 inches, and weigh, when loaded, 152,000 pounds; and, with the tender, 248,000 pounds. The total heating surface is 2,583 square feet, which is about 100 square feet more than for those of the 1889 design.

Some of the principal features in the design of these locomotives may be mentioned. Cast steel is used for the driving wheel centers, and the side and main rods are of mild open hearth steel. The driving boxes are of gun iron. The exhaust nozzle is single. An extended piston rod is used. This rod is supported at the front cylinder head and thus serves to relieve the bottom of the cylinder of the weight of the piston. The grate is of the common rocking type. It is worked by a lever which is locked when in the vertical position. The saddle has been cored, leaving five ribs, three of which are 1 inch thick and two are ¾ inch. This design gives large air spaces, protecting the live steam passages, and while it strengthens the saddle at a place where it often proves to be weak, it does not detract from the outside appearance.

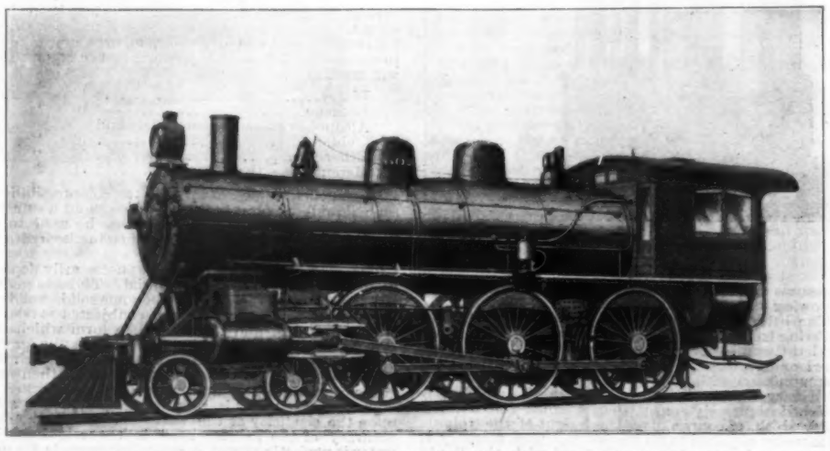
On the frame there is a cast steel filling between the



No. 12.—EXPRESS PASSENGER LOCOMOTIVE OF THE ATLANTIC TYPE, 1896.



No. 13.—AMERICAN TYPE OF HIGH-SPEED EXPRESS PASSENGER LOCOMOTIVE, 1899.



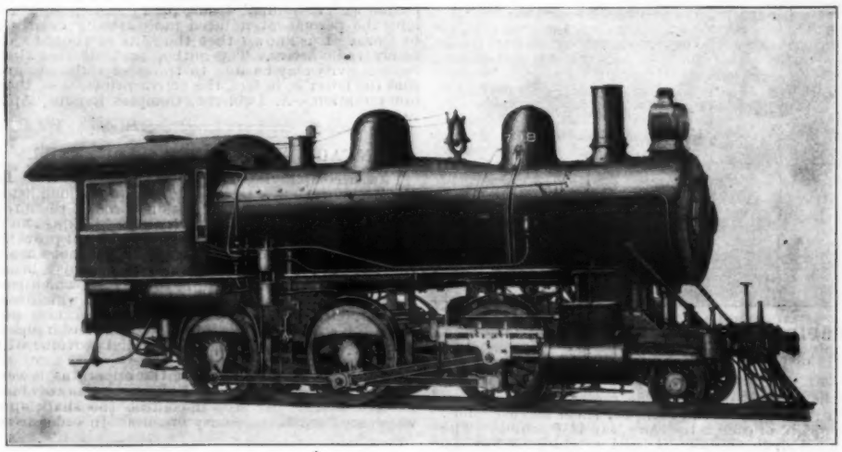
No. 14.—TEN-WHEELED EXPRESS PASSENGER LOCOMOTIVE, 1899.

cylinder and the front pedestal. These engines are capable of hauling a train load of 1,800 tons up grades of 10 feet to the mile at a speed of 19 miles an hour.

The use of comparatively small driving wheels and the elevation of the boiler to so great a height gives a distinctness of separation between the working parts and the shell that was not obtained in those designs having a lower center of gravity.

The last class engine shown is No. 16, which is known as the "Consolidation" type. It is extensively used in the freight service of the United States. It is not used for passenger traffic. Its peculiarity lies in the arrangement of the wheels, of which there are four pairs of driving wheels and one pair of truck wheels at the front end.

As in all of the large modern locomotives, the firebox



No. 15.—MOGUL LOCOMOTIVE FOR FREIGHT SERVICE, 1899.

is placed above the frames and is carried by links pivoted to plates riveted to the side sheets and also to studs bolted to the frames.

Such an engine as this one has a total weight of about 185,000 pounds, of which 165,000 pounds are upon the driving wheels. The cylinders are 22 inches in diameter, with a piston stroke of 30 inches.

The driving wheels are 4 feet 8 inches in diameter, and all but the second pair have flanges, these being fitted with blank tires.

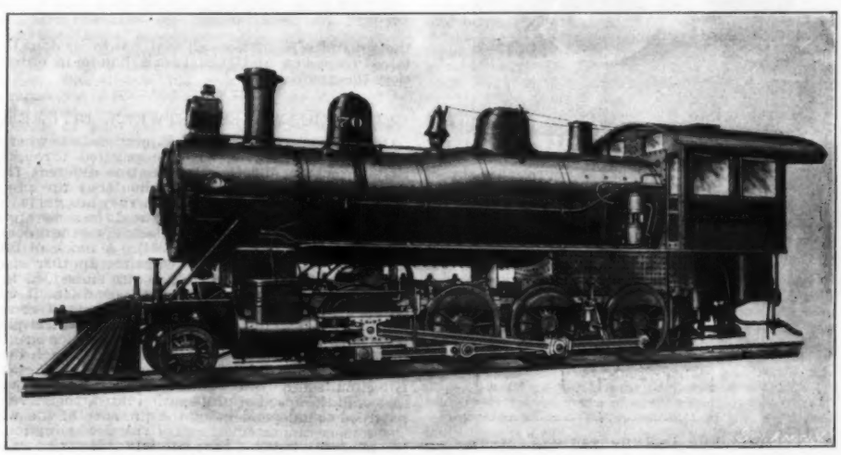
The boiler is of the radial stay extended wagon-top type. It is designed to carry a steam pressure of 200 pounds per square inch and has a total heating surface of 2,800 square feet, of which 2,633 square feet are in the tubes and 177 square feet in the firebox.

Cast steel is largely used, the following parts being of that material: Wheel centers, cylinder heads, crossheads, steam chests and covers, foot plate, front brace plate, driving boxes, spring saddles, dome ring, rocker shaft, expansion pads, and couplers.

The cab is of steel plate. The engine is fitted with the automatic air brake, with shoes applied to each of the driving wheels. It also has a pneumatic sander for the distribution of sand upon the rail.

Owing to the great height of the boiler, an auxiliary dome is placed between the main dome and the cab, and on this are placed the safety valves.

While an engine having the weight and dimensions



No. 16.—CONSOLIDATION LOCOMOTIVE FOR FREIGHT SERVICE, 1899.

of this one is by no means the largest of its class that has been built, it nevertheless represents a high standard of present practice. In fact, its size is such that the limits of increase have about been reached. The height of the center of the boiler above the rails is 8 feet 6 inches, so that the clearances of ordinary roadway structures, such as tunnels and bridges, have been nearly filled, and these are the determining factors that check the growth of the locomotive. When the weight, strength, and power of the large locomotives of the closing years of the century are compared with those of twenty years before, a notable advance is at once apparent. The heating surfaces and weights have been more than doubled, with a corresponding increase of power. If the comparison is extended back to the early engines of the series, we find that it becomes a matter of ranging pygmies with giants, for the increase of capacity has been fully ten-fold.

This, in brief, is the story of the growth of the locomotive in the United States during the seventy years that have passed, as illustrated by these drawings. It is a bare outline of outside appearances that merely touches an important detail here and there. But to realize what the advance really means, every detail of every part should be scrutinized. There has not been a piece in the whole locomotive structure that has not been the subject of experiment, and trial, and error; and, with the growth of the locomotive, there has arisen the whole fabric of the great iron and steel industries, that have made the building of this modern machine a possibility out of the impossibilities of 1831, just as it would have been impossible to use it at that time had its construction been effected by some supernatural agency.

JOUKOWSKY'S EXPERIMENTS ON THE HAMMERING OF WATER-PIPES.

WE have received from St. Petersburg an interesting pamphlet by Prof. N. Joukowsky, on the hammering in water-pipes. Experiments were made upon pipes 2, 4, and 6 inches in diameter, connected with a 24-inch main and provided with valves, whereby change in pressure could be readily produced. Prof. Joukowsky has shown that the compression of the water and the expansion of the walls of the pipe produce shock-waves which are propagated in the pipes. The rapidity of propagation was measured by an electrical chronograph; and the rise and fall of pressure at various points was recorded by a modified Crosby indicator. The experiments proved that the velocity of propagation of the shock is constant and independent of the magnitude of the shock. This velocity depends upon the material of the pipe and the relation of the thickness of the walls to the inner diameter of the pipe. Since in ordinary cast-iron pipe the relation mentioned decreases slightly with an increase in the size of the pipe, it follows that the velocity of propagation is smaller for larger than for moderately sized pipes. The velocity is constant, whether the shock be produced by suddenly checking the flow at the discharge-end or increasing the pressure at the inlet. The hydraulic flow or shock acts uniformly throughout the length of the pipe. Its magnitude is proportional to the loss in velocity of the water and to the velocity of propagation of the shock-waves in the pipe. That a shock periodically oscillates is proven by the reflection of the wave between the two ends of the pipe. The flowing water has no appreciable effect upon the shock. A dangerous increase of the shock is caused by the passing of the shock from pipes of large diameter to those of smaller diameter. The force of the shock, in such a case, is doubled at the closed end of the pipe; and since this doubling may be repeated several times, the pressure may attain great magnitude. The simplest method of preventing shock is the introduction of devices to insure the slow opening and closing of valves. The time required for closing the valve should be proportional to the length of the pipe. Air-chambers near the valve effectively prevent shock, but are with difficulty kept full of air. A safety valve relieves the shock to a degree dependent upon the strength of the spring.

HOW WIRE FENCING IS MADE.

THE rapid extension in the use of American steel wire fencing renders the following account of how such products are made of widespread interest. The factories described are among the largest in the country and are engaged in making every kind of fencing in general demand, including field and hog fencing, poultry fencing, lawn and cemetery fencing and park fencing. Over 130 different machines, according to Farm Machinery, are used in these factories, and the variations in height, fabric, mesh, pickets, etc., constitute a remarkably large assortment. No less than 222 different styles, sizes and varieties of fencing are constantly carried in stock to supply the trade. The highest fence made is 8 feet and the smallest regularly turned out is 13 inches. The machines used are in each case specially adapted to turning out one kind of fencing, but in manufacturing narrow widths two rolls of fencing are often turned out at the same time on one machine.

The improvements made in the more recent machines are quite marked. In the first machines, for instance, the pickets for hog and field fencing were crimped in a special machine for that purpose and then inserted by hand in their proper place in the weaving machine, previously prepared with cables or longitudinal wires after the fashion of a cloth weaver's warp. In the improved machines the whole process is done on one machine, which automatically draws the wire from a side reel into the proper place for a picket, cuts it off and crimps it and locks it into the cables. Probably the most interesting machines are those weaving poultry fencing. In these fencing wire is wrapped alternately on two strands of the heavier wire or cables running longitudinally. In crossing back and forth they form the mesh, which can be made large or small as desired. The guides through which the fine wires pass are shifted automatically from one cable to the other as soon as the necessary warps are made. The shifting is done by an ingenious arrangement in connection with the cable twisters in the head of the machine, operated by a series of gears moved in unison with one another. The poultry fencing thus made is of unique pattern, having a cabled selvage and a cable every foot in the height of the fence. The lines all being parallel in this fence, the tension is distributed equally throughout it and on a straight line. Owing to this construction, a full roll of 20 rods can be stretched at one time without injury. The posts are placed 16 to 20 feet apart. This enables a saving to be made of fully half the number of posts ordinarily required, while top and bottom rails are rendered unnecessary, thus making a saving in that respect. The body of the fencing can be stretched as firmly as the edges.

The weaving machines are all built to weave the fencing in a horizontal position, the completed fencing being rolled on a large drum or cylinder not very high from the floor, so that the finished roll can easily be taken off the drum and removed. The machines are arranged with the finishing ends near the sides of the factories, thus leaving a space down the centers of these buildings for bringing in the coils of wire to be woven. These coils can thus be placed on reels on the right or left for feeding the weaving, picket or cable twisting machines. In some of the weaving machines it is desirable to feed the wire from long spools instead of coils, and an arrangement has been devised for filling a large number of spools at one time. The company have adopted 20 rods as the standard length for their rolls of field and poultry fencing. The old standard for poultry was 150 feet, but it has been found in practice that the new standard is better for the trade, as not so much scrap accumulates on the hands of a retail merchant with the greater length. Lawn fence is put up in rolls of 300 feet.

An important adjunct to the fence business is the manufacture of gates and posts. An entire building is devoted to this purpose, which is run by its own motor and is equipped with punches and other machinery. The company manufacture three distinct lines of gates, namely, steel frame garden and lawn gates, wood frame garden, all lengths, and pipe frame farm gates. Their pipe frame gate is of novel construction, which secures unusual rigidity. Instead of being bent at the corners, as is customary, the pipe is cut to the exact lengths required for the sides and ends. Two malleable castings are then used for each corner, one on the inside and the other on the outside, which are of a shape to hold the ends of the pipes firmly when bolted together. The castings are made with a lug on each end to enter holes drilled in the pipes, and thus provide additional rigidity. Diagonal braces extend across the gate, passing through holes in the inside corner casting and secured by nuts on the ends. Fencing of any pattern desired is fastened to the framework, and thus a farm gate is secured which is at once ornamental, light and unusually strong and rigid. No less than 180 different kinds of gates are carried in stock, but special gates are easily made to fit any space. Various patterns of steel posts are made for either lawn or field fencing.

The company built a machine shop two years since, and now make all their own machines. This was found desirable, because improvements are constantly being devised and new forms of machines are being designed and tested, and the progress of such work can be more easily supervised when done in their own shop. The equipment is of the most approved character, comprising automatic gear cutters, milling machines, drills, planers, etc. The scope of the work done is indicated by the fact that a 16-foot planer and a 5-foot radial drill are included in the equipment. An electric motor runs all the machines in this shop.—The American Exporter.

Soap Trust in Germany.—Consul-General Guenther, of Frankfort, under date of April 5, 1900, reports that 85 per cent. of the German soap manufacturers have joined the trust, and the rest, it is said, are to be coerced into it by underselling or by cutting off the supply of raw materials. A union of consumers is recommended as a counter remedy.

THE FIELD GUN OF THE BOERS.

The field artillery of the Boers consists for the most part of Creusot 3-inch rapid-fire guns made after the 1895 model. These guns were purchased by the South African republic during the year 1896, after most satisfactory trials had been made under the direction of a committee consisting of artillery officers, who were sent to Creusot by the French government at the request of that of the Transvaal. The data that follow are taken from the official documents which were published in the Revue d'Artillerie of March, 1897, after the termination of the experiments.

The gun, which is constructed of forged and tempered steel, has a 3-inch bore. Its total length is 8 feet and its weight is 726 pounds. The body of the gun consists of three elements: (1) a tube in which the breech piece is fixed; (2) a sleeve covering the tube for a length of 3·6 feet; and (3) a chase hoop. The chamber is provided with 24 grooves of variable pitch, which have a final inclination of 8°.

The system of breech closing is that of the interrupted screw, which presents four sectors, two of them threaded and two plain, so that the breech is opened or closed by a quarter revolution of the screw. The mechanism is of the Schneider system, patented in 1895, and has the advantage of allowing the opening or closing of the breech to be effected by the simple motion of a lever from right to left, or vice versa.

The gun is fired by means of an automatically cocked percussion apparatus. A safety device prevents any shots from being fired until after the breech is closed.

The carriage is provided with an hydraulic recoil cylinder fitted with a spring return. It is also furnished with a "spade" which is placed under the stock at an equal distance from the trail and the axle, and which is of the model that Gen. Engelhardt has adopted for the Russian artillery.

During a march, this spade is turned back and fastened to the stock. The carriage is likewise provided with a road brake, which is to be employed in firing only when the nature of the ground is such that the spade cannot be used.

The gun is placed in a bronze sleeve that carries the brake cylinders and the various other connecting pieces for the return spring and the aiming apparatus.

The hydraulic recoil consists of two cylinders placed laterally and at the height of the axis of the piece.

The axle has the peculiarity that in its center there is a wide opening in which are placed the cradle and the gun. It is provided with two screw trunnions around which the pivoting necessary for lateral aiming is effected. This arrangement of the gun with respect to the axle has the effect of greatly diminishing the shocks that firing tends to produce.

Elevation and depression are accomplished by rotating the axle in the wheels of the carriage. This is done by means of a crank which, through an endless screw and pinion, controls a toothed sector attached to the sleeve.

Pointing in direction is done by means of a lever known as a tail piece. Mounted upon the axle there are two small sights, forming a line of aim, that permit of bringing the carriage back in the direction of the target as soon as a shot has been fired. All that the gunner has to do is to give the piece a slight displacement laterally with respect to the carriage by means of a handwheel which turns the gun two degrees to one side or the other.

The line of aim is found by a back and front sight arranged upon the right side of the sleeve in which the gun is mounted. The back side permits of aiming while the gun is being loaded. It carries a small oscillating level that indicates the elevation of the gun during rapid firing.

The weight of the carriage, without wheels, is 1,146 pounds, and with wheels, 1,477.

The ammunition consists of cartridges containing charge and projectile and having a total weight of 19 pounds. The powder employed is of the smokeless kind, designated by the letters B N. The weight of the charge is 1¾ pounds. The projectiles are of three kinds: ordinary shells, shrapnel shells and case-shot. The weight of each is the same, say 14¼ pounds. The shrapnel shells contain 234 balls weighing 155·8 grains each, and an explosive charge of 3·13 ounces.

As the gun can be pointed at a maximum angle of 20°, and the initial velocity is 1,837 feet, the projectiles can be fired to a distance of 26,248 feet.

The crew necessary to serve the gun consists of six men—a gunner, a man to maneuver the breech piece, a man to maneuver the pointing lever, two men to pass the ammunition, and a man to regulate the fuse. The rapidity of firing can easily be raised to ten shots a minute.

The accuracy of the gun is most remarkable. Upon the occasion of the trials made when the guns were received, the following firing was done: a regulating shot, a first volley of six shots in 42 seconds, and a second volley of six shots in 46 seconds. The projectiles, directed at a black circle upon a target placed at a distance of 394 feet, gave the grouping shown in Fig. 4.

The rectangle comprising the 13 indentations was 18·5 inches in width by 13·25 in height.

The fore carriage of the gun and that of the caisson are identical. They carry a chest containing 36 cartridges, and are capable of accommodating four men.

The back carriage of the caisson carries two chests like that of the fore carriage.

The total weight of the gun and fore carriage loaded is 3,790 pounds, and that of the caisson 4,330.—For the above particulars and the illustrations, we are indebted to La Nature.

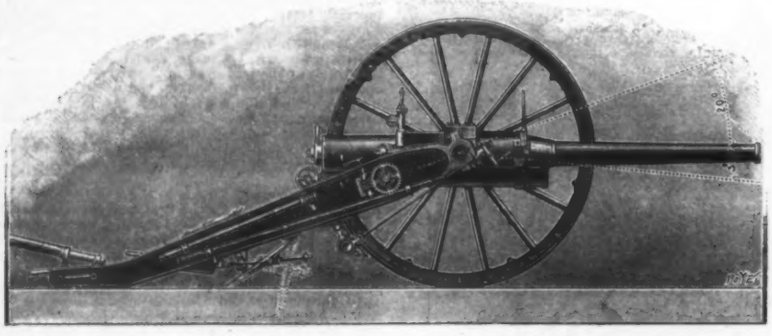


FIG. 1.—CREUSOT 3-INCH RAPID-FIRE GUN.

(Elevation of the gun, showing one wheel removed.)

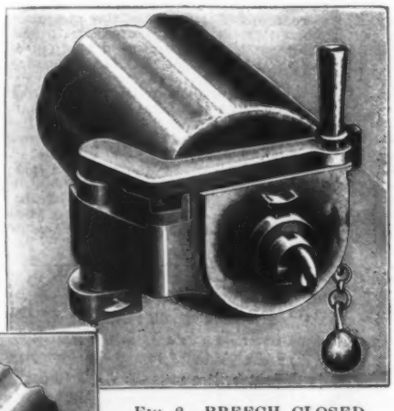


FIG. 2.—BREECH CLOSED.

FIG. 3.—BREECH OPEN.

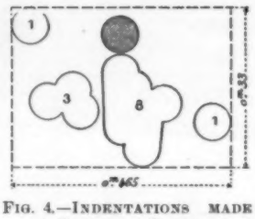


FIG. 4.—INDENTATIONS MADE BY THIRTEEN PROJECTILES UPON A TARGET PLACED AT A DISTANCE OF 120 YARDS.

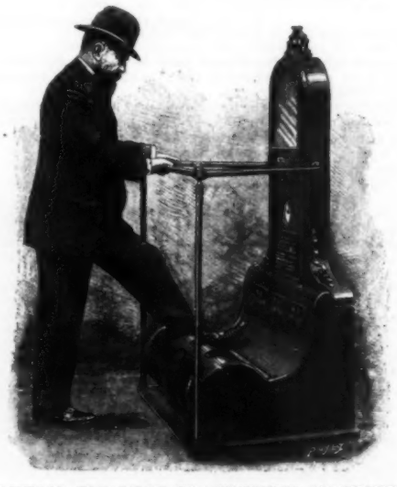
ACTINIUM.

By treating pitch blende with the reagents used for the extraction of metals of the iron group, and more especially of titanium and thorium, A. Debierne has succeeded in discovering a new radio-active substance, which has the general characteristics of thorium, but does not follow that metal through all its reactions. If a barium or bismuth salt is added to a solution of the new substance, the salt added may be eliminated by means of ammonia or sulphureted hydrogen, without thereby eliminating the radio-activity. This proves that the latter is not due to either radium or polonium. The author calls the new substance "actinium." It produces the same phenomena of fluorescence, photographic action, and ionization as radium and polonium. All the experiments of magnetic deflection made by Giesel, Meyer, Schweidler, and Becquerel may be repeated with actinium. It also produces, to a slight extent, the permanent induced radio-activity described by Curie. It is known that the salts of thorium are feebly radio-active. The author suggests that their radio-activity may be due to traces of actinium, and that the latter is, in fact, the active principle of thorium radiation.—A. Debierne, Comptes Rendus, April 30, 1900.

AN AUTOMATIC SHOE BLACKENER.

The accompanying engraving, borrowed from La Nature, represents a recent addition to the long list of automatic apparatus set in motion through the introduction of a coin. It is a machine for blacking shoes. After a coin has been introduced into the slot provided for the purpose, the customer places his foot successively in the first compartment, where there is a brush for removing mud and dust, in the second, which contains a blacking brush, and in the third, which contains a polishing brush. The whole operation is performed in a minute and a half, and the different phases of it may be watched by means of a dial provided with a needle.

The interior arrangement of the apparatus is very simple. An electric moter of feeble power, say of about 180 foot pounds per second, controls the shaft, upon which are fixed three rotary brushes. In order to set the apparatus in motion, all that has to be done is to introduce a coin and then turn a handle in order to close the circuit.



AUTOMATIC SHOE-BLACKENING MACHINE.

ELECTRIC WAVES BETWEEN BITUMEN.

C. Gutton has examined the question as to whether electromagnetic waves, when propagated through a medium whose dielectric constant is different from unity, have the same velocity when they are propagated freely through it, and when they are guided by a wire. For the experiments, he used the same apparatus as for his experiments on electric wire waves (see The Electrician, vol. xliii., p. 364). A block of bitumen, 1 m. long, was balanced against another of exactly the same size, but having a wire embedded in it through which the waves in the second circuit were propagated. The waves of the first circuit were sent through the free block by means of cylindrical parabolic mirrors. When the rates of propagation are the same, the two wave systems interfere with each other and produce no effect on the coherer which bridges the two circuits at a distant point. Such was actually the case, and the speed of propagation must, therefore, be regarded as independent of the presence of the wire. The same arrangement allows of the determination of the refractive index of the material for Hertzian waves. Compared with air, the refractive index of bitumen comes out as 1·870 without the wire, and 1·885 with the wire. The author considers that the small discrepancy here indicated is probably due to a lack of perfect identity of structure in the two specimens of bitumen, though it would, of course, be more satisfactory to have this made evident by further experiments on different specimens.—C. Gutton, Comptes Rendus, April 2, 1900.

MAGNETIZED COHERERS.

In the course of some experiments in wireless telegraphy made between Brest and Ouessant, C. Tissot hit upon a device which considerably increased the sensitiveness of the nickel or steel coherer used, and at the same time made it work with greater regularity and certainty. The device consists in placing the coherer in a magnetic field whose lines of force are parallel to

the axis of the tube. The latter should contain some kind of magnetic filings, steel, nickel, or cobalt. The electrodes should preferably be non-magnetic, and the tube may be placed between the polepieces of an electromagnet feebly excited. The first result observed is that the terminals may be drawn very much further apart without annuling the action. The distance may, in fact, be increased from 1 mm. to 6 mm. Both the current traversing the coherer and the magnetic field controlling it should be feeble, as otherwise the decohering action is interfered with. One of the most striking results was the exchange of signals with the warship "Massena," over a distance of 18 nautical miles, with signaling masts only 100 feet high. The action of the magnetic field appears to be purely mechanical. It is important on account of the ease of regulation which it introduces, even in the case of sealed tubes, whose sensitiveness can easily be brought to the point required. When the field is suddenly withdrawn, a very slight shock suffices to decohere the apparatus. This suggests the possibility of working the magnet by a relay, and thus securing automatic decoherence.—C. Tissot, Comptes Rendus, April 2, 1900.

HEALTH CONDITIONS IN THE HAWAIIAN ISLANDS.

By CHARLES E. DAVIS, M.D., late Major Surgeon of First New York Volunteer Infantry; formerly in charge of the military hospital at Honolulu.

THE Hawaiian Islands are in an ideal location, being just inside the tropics. There is never danger of frost (except upon the mountain tops), and as they lie in the line of the trade winds, extremes of heat are unknown; although the humidity, at times, is quite unbearable.

The group consists of eight inhabited and four uninhabited islands, lying between parallels 18° 50′ and 23° 5′ north latitude and meridians 154° 40′ and 161° 50′ west from Greenwich. A straight line drawn, connecting the two most distant points on the islands, would measure about four hundred miles. Honolulu, the chief seaport town, is situated 2,100 miles from San Francisco and 4,800 miles from Hong Kong.

	Area in flat sq. miles.	Acres.	Height in feet.
Hawaii	4,210	2,000,000	13,800
Maui	760	400,000	10,032
Oahu	600	360,000	4,030
Kauai	590	350,000	4,800
Molokai	270	200,000	3,000
Lanai	150	100,000	3,000
Niihau	97	70,000	800
Kahoolaue	63	30,000	1,450
Total	6,740	3,510,000	

The accompanying table gives the area and highest elevation of the eight inhabited islands. The four others are small and unimportant. All these islands are of volcanic and coral origin. Upon the largest of the group, Hawaii, stands Mauna Loa, the greatest active volcano in the world. Upon the island of Oahu, where is situated Honolulu, the United States troops were, and still are, located at Camp McKinley. Here are to be found no less than seven extinct craters. The city lies at the foot of one crater (Punch Bowl), and the camp at the base of another (Diamond Head), and are four miles apart. These craters are distinctly defined. The cones have been built up of successive layers of lava. Eruptions occurring at intervals give to the sides of these mountains a stratified appearance, which is easily confounded with a like appearance produced by water.

None of the seven craters on Oahu has been active within the memory of man. Upon the island of Hawaii, Mauna Loa, or Great Mountain, is at present active, and a few weeks ago threatened, in its immense flow of lava, to destroy much valuable coffee and sugar land on the "koua" or southwest side.

The soil of the islands is very fertile, and is composed of volcanic lava, disintegrated by atmospheric agencies. The climate and rank vegetation favor the decomposition of lava and rapid formation of soil.

The "coral insect" or animal—Prof. Agassiz calls it a species of jelly fish—by its industry has added acres to the territory that fringes the shores of these islands.

The mountainous character of this country gives a great variety of temperature. Torrid heat can be found at times in some spots sheltered from the trade winds; frost and snow exist upon the tops of the highest mountains. The invalid in search of a change of climate has but to travel a few miles to find any temperature the physician may prescribe. The air, coming over so many thousand miles of sea, is remarkably pure. The average temperature is about 74° F. In observations made by Prof. A. B. Lyons, from 6 A. M. to 2 P. M. and 9 P. M. each day throughout the year, for seven years, the minimum in Honolulu has been 54°, the maximum 90°.

These islands lie in the track of the Japanese gulf stream called "Kuroshiwo," which has much to do in preventing extremes of heat and cold. The contrast between the windward and leeward sides of the island is very marked. The eastern sides are windy, rainy, and heavily wooded, while the western coast possesses a warm, dry climate, with scanty vegetation.

Trade winds blow constantly from the northeast for nine months of the year, and have an average velocity of twenty miles an hour, keeping the temperature cool and invigorating. During the rainy season, the wind often shifts to the south, bringing intense humidity. The natives calls this the "koua" or sick wind; it often lasts twelve or fourteen days, and is very unhealthful and depressing, also blighting temporarily the vegetation near the shores.

The ethnological problem exhibited in this group of islands, though a complex one, has never, from the first, been difficult of solution. It is but another demonstration of the old hypothesis, "the survival of the fittest," where the unconquered Anglo-Saxon rules every other people with whom he mingles. The accompanying census enumeration shows, for the year 1896, a total population of 109,020 souls, made up from the representatives of ten different peoples and no less than six different races:

Native Hawaiians	31,019
Part native	8,485
Hawaiian-born foreigners	13,733
Americans	2,266
British	1,538
German	912
French	75
Portuguese	8,232
Norwegians	216
Chinese	19,382
Japanese	22,329
Polynesians	409
Other nationalities	424
Total	109,020

Added to this already cosmopolitan population is found a combination, or mixture of white and dark blood, which, of frequent occurrence, is found to possess in the offspring in a marked degree the color of the dark parent, with the tastes, ambition, and often the refinement of the white parent. Of this cosmopolitan population, it is especially to be noticed that only 3,804 persons can properly be classed as Anglo-Saxons, and that the curious fact exists, explained only by the indomitable courage and persistence of the race, that these 3,804 Anglo-Saxons, constituting as they do but a small fraction of the population, have taken in their hands the control of affairs, political and governmental. That this should be the racial condition that would finally be established has never been a question of much speculation since the time that the great natural resources of the islands became known, and tempted with the promise of wealth the adventurous Briton and the practical American.

The preceding enumeration shows a large population of Chinese and Japanese. This element never has, and probably never will, seriously figure in the political history of these islands, since nearly all were brought here from their native countries by the Anglo-Saxon, who had already acquired possession of the richest portions of the islands. They were brought, too, under the contract labor system, by which they were little better than the white man's slave, whose lot it is to bear the heat and burden of the day.

The Portuguese, of whom there are more than eight thousand, are a quiet, unobtrusive people, content to live simply and work industriously for their day's wage. Very few Portuguese are progressive and independent enough to establish their own business. They segregate in the parts of the city that are given up almost exclusively to them. They marry young (seldom outside their own people), raise large families, and are not, to any marked degree, assimilated by any other race. The native Hawaiian is undoubtedly of Malay-Polynesian origin. This philologists have established through a study of the language, which they declare to be directly derived from that spoken by the Polynesians. They probably emigrated to these islands in canoes via Samoa. Their skin is dark, resembling that of a half-white in the States. Their hair is raven black, very luxuriant, and straight or slightly waving. Their faces are broad, noses rather flat, and lips thick. They are of moderate height.

When in 1778 Captain Cook discovered, explored, and named the islands after an Englishman, the Earl of Sandwich, he estimated the population at 400,000, which most likely was too great. In 1823, when the missionaries arrived, 120,000 was the estimate. To-day the natives number about 31,000. They are becoming extinct as a race, and a few more generations will see the last of them and of the Hawaiian language. However, no small fraction is by intermarriage becoming assimilated by the white races, especially the Anglo-Saxon, that have settled here. Under the rule of Kamehameha I., who consolidated all the petty chiefs of the eight islands under one monarchical government, they were warlike and prosperous. But with the advent of the white man the extinction began. They are immoral, and because of improper medical attention (a necessity which they do not understand) they are diseased. Syphilis and leprosy have made sad inroads on their general health and fertility. The missionaries reduced their language to a written form, which was gratefully received and quickly acquired. Many of the natives show an aptitude for languages, and usually acquire English, and often Japanese and Chinese, in addition to their own. An interesting item to notice is, that there is no word for virtue—and for their omission the people are paying the penalty.

The health problem in the Hawaiian Islands is almost as serious a question for the United States to deal with as it is in Cuba or Porto Rico. In some respects it is greater, in proportion to the population; the condition existing in the two large cities (Honolulu and Hilo) is identical with that which confronted the military commanders of Santiago and Havana. If, added to the general unsanitary condition of these two cities, there should be placed in them a certain number of reconcentrados, starving and afflicted with all kinds of diseases, the problem here presented would be the same. That some radical action must be taken at once is most apparent to any one who has had anything to do with matters pertaining to public health, or who has given the subject a moment's consideration.

Honolulu offers the best example of life in these islands from a health point of view, because it is the largest city, and said by the inhabitants to be the healthiest. It is located, as mentioned above, on the island of Oahu, which is about thirty miles long, with many hills and mountains, rising to the height of several thousand feet, between which are many fertile vales and plains. But owing to its general formation, the coast lines are most available for habitation and cultivation. It is on one of the level tracts of land, between the mountain and the sea, that Honolulu is situated. In early days the plain was the remnant of a lava-flow, or perhaps the bottom of an extinct crater, with the side fallen out. It is within the memory of the earliest inhabitants when it was nothing but beach sand and lava-dust. The subsoil is black sand, very porous, and quickly absorbs all fluids cast upon it. The general drainage is bad, because of the fact that the hills rise somewhat abruptly from the sea, leaving a great tract of land but a few feet above sea-level.

The transformation of Honolulu from grass huts and cocoa-palms to modern houses, parks, and streets has been very rapid. Good roadways of coral blocks have been laid; palaces and fine public buildings have been constructed, also mansions large and small, elegant detached houses, modern schools, churches, and museums. Tram-cars, water-works, and electric lights are enjoyed. Parks filled with beautiful tropical foliage dot the city here and there. Streets and driveways are nicely shaded with royal and cocoanut palms. And yet, with all this seeming love and beauty and show of intelligence and refinement, Honolulu might almost be considered filthy, and a spot full of danger to its inhabitants. In what might otherwise be the garden city of the world, certain classes have disregarded the laws of nature and hygiene, and actually defiled their own habitations.

The chief part of the city trade is carried on in a space of about half a mile square, closely built, densely populated, and largely made up of one and two story houses, the sort usually found in tropical countries. Of late years, modern stone and brick structures are taking their places. In this part of the city, Chinese, Japanese, and some natives are found in great numbers; they generally live and sleep in one room, and the small yards in the rear of their houses are entirely taken up with cesspool and vault. On one or two of the principal streets it is impossible for pedestrians to travel without being met everywhere by the most obnoxious odors. No part of this city has had a sewerage system until the present time, when one is being constructed through the main thoroughfares. If the history of other cities repeats itself here, it will be some years before this comes into general use. At present, all refuse matter is disposed of in cesspools. In many cases they are properly built and regularly pumped out by scavengers, but in the majority of cases they consist of holes in the ground, with wooden boxes sunk into them. In many cases refuse is cast upon the ground to decay and rot in the tropical sun.

This condition of affairs has continued for the past fifty years. The city is honeycombed with cesspools and privy vaults. The outlying districts, which are not so closely built, have added to this the pestilential nuisance of rice, taro, and banana patches which are constantly flooded with water. Interspersed here and there will be seen duck-ponds and pig-sties; so that from any height overlooking the city the picture is not unlike Venice with its many canals. These pools of stagnant water, added to the lakes and lagoons in the public parks, are favorable breeding-grounds for all kinds of disease, especially in this climate. We are told by those who make the subject a study that a waterlogged tract of land, between mountain and sea, is the best place for the propagation of malaria. Add to these conditions lava-dust, of which the atmosphere is full and which at times covers everything in clouds, and is so fine that it penetrates one's clothing; a water supply which is partly artesian, and partly collected from mountain streams (admittedly so full of decomposed vegetable matter that it is the rule to boil it before it is drunk); an even temperature which seldom falls below 72° F., with sunshine and rain almost daily during the winter or wet season; with very little attempt at street cleaning—and we have the conditions which are bound to breed disease wherever they exist.

In this city of thirty thousand inhabitants of mixed races, the death rate is thirty-five per thousand, or thereabout. Typhoid fever has been constantly on the increase, and is always endemic. Pernicious tropical malaria is a common complaint, while rheumatism, catarrh, and bronchitis are very prevalent. The climatic conditions are especially bad for those suffering from rheumatism or lung diseases. The death rate is steadily increasing, as the incomplete records of the board of health show. The causes of death have not been carefully recorded, and, until the last few months, interments were made without permits. The mortality is greatest among the natives. Venereal diseases in the worst forms prevail among the lower classes.

One cannot better illustrate the effect of the conditions in Honolulu than to recall the recent epidemic of typhoid fever and malaria which prevailed among the United States troops stationed there. To be sure, they lived in tents, and had to contend with the hardships of camp life, but had not the disease been there they would not have been so afflicted. Now that these islands have been annexed, the people who live there should look at these conditions as they exist, fairly and squarely, and let the United States government know just how badly they need some active health work done.

The island government is doing all it can to improve the sanitary conditions, but necessarily has many local influences to contend with, as well as native prejudice, which leads the inhabitants to conceal their sickness. Late reports from Honolulu show the above statement to be true among the Chinese, who evade the authorities, and will not report cases of bubonic plague, fearing cremation.

The question of leprosy alone is international, now that we have adopted twelve hundred lepers in these islands, with many more in Porto Rico and the Philippines. Some national health legislation must be the result, and this disease must be properly segregated and treated in a more complete way. New schools, workhouses, and hospitals should be constructed on the island of Molokai, for these afflicted people to live, work, and be treated in. At present no attempt at classification of cases and treatment on Molokai is made. To be sure, the Hawaiian government, through the board of health, with Mr. W. O. Smith, its efficient president, has gone further than any other in the segregation of lepers, and much credit is due them, but this disease being now more than ever a possible factor in the diseases of the United States, it becomes a national question, and one of the greatest importance. A local government will take years to do, in a health and sanitary way, what a proper health commission, not of the country, could accomplish in much less time.

For Honolulu I should heartily recommend the completion, as soon as possible, of the sewerage system, the filling of all stagnant pools, rice, taro, and banana patches; putting an end to the breeding of ducks and pigs in the city limits. Then with the sea bathing and many natural advantages it would become the garden city of the world.

In conclusion, I should like to add a word in favor of a national health department, with a representative in the Cabinet. I am led to believe that medical societies

throughout the United States will make a strong effort in this direction, as the necessity for such a department is daily growing more apparent.—Medical Record.

ARTIFICIAL LIGHT FOR PHOTOGRAPHIC WORK.

AN article in the Photographische Mittheilungen (1st April issue, 1900, p. 16), summarizes the principal points of advantage and disadvantage incident to the use of artificial light, when negatives are to be taken. The considerable variations in the intensity of daylight are often a reason for the adoption of an artificial source of light, while in some cases there is no choice. Magnesium in its various forms is first considered; but the smoke problem is always present, and whatever precautions are taken, it seldom happens that many exposures are made without the atmosphere being more or less clouded. The electric arc light is satisfactory enough, provided that sufficiently large ares are used, and it is not essential to give extremely short exposures; but unless an electric supply can be had from a central station, the arc light is, ordinarily, out of the question, as but few can install appliances for producing powerful arc lights. As a means of work away from home, and when the photographer has to take his own means of producing light, or to work in a place not specially fitted, the writer appears to think that an acetylene generator is often the best apparatus to employ, seven or eight jets of sixty candles, and burning forty liters of gas per hour, serving to take an ordinary portrait, with two seconds' exposure. Incandescent gaslight is by no means unsuited for ordinary photographic purposes, and many of the London process workers use this light for copying—an incandescent burner, with a stronger draught than usual, being ordinarily employed. In spite of the extended use which has recently been made of incandescent gaslight for ordinary lighting purposes, but little seems to have been done toward adapting it to the special needs of the photographer, by making each lamp quite portable and independent—a very important matter when special effects in lighting are to be quickly realized. Surely there would be no insurmountable difficulty in constructing portable incandescent gas lamps, each on a small, steel receptacle containing compressed coal gas, and containing supply for an hour's burning—amply sufficient for most photographic needs. With a suitable hand-pump the pumping in of fresh gas from the main would be a very simple matter, as the compression of coal gas does not involve those special risks of internal combustion which necessitate such careful precautions when oxygen is compressed. When it is remembered that incandescent gaslighting is more than half a century old, it is surprising that it is not brought to greater perfection and convenience. In The Illustrated London News for May 17, 1851, p. 425, third column, mention is made of the incandescent gaslight, with platinum gauze as a mantle, this system having been then employed in some of the French manufactories. Although the expense of platinum mantles has put them out of use for the present, it is by no means improbable that those using the incandescent gaslight for photographic purposes would find it advantageous to use platinum mantles (preferably sprayed over with a solution of suitable incandescing earths) rather than the fragile earth mantles now sold. A well-formed platinum mantle may be very easily made of fine wire, by anyone who likes to notice how the first lesson in basketmaking is given to children in the kindergarten departments of the board schools, and the finished mantle should weigh about one-twelfth of an ounce.—The Amateur Photographer.

A NEW SOURCE OF ERROR.

WHILE determining index corrections of the compass declinometers belonging to the United States Coast and Geodetic Survey, G. R. Putnam observed motions of the magnetic needles of such a nature as to leave no doubt that the glass covers of these instruments carried strong electrostatic charges, caused by atmospheric conditions, which at the time were especially favorable, the weather being dry and cold. In two of the declinometers, in which the glass covers were replaced by brass plates, with only small pieces of glass covering the openings through which to observe the points of the needles, no erratic movements were noticed, and repeated determinations of their index corrections agreed with each other within the error of observation; while before, nearly all observers using these instruments reported occasional discrepancies in their results which could not be accounted for. In reporting upon this source of error, E. G. Fischer raises the question as to what may be the effect of the same phenomenon upon the magnetic needle in other instruments. The theodolite magnetometers do not seem to be sensibly affected, but in the dip-circle, the manner of housing the magnet is such as to immediately raise the question whether the frequent want of accord between the results obtained may not be due to electrostatic disturbance. As a remedy, both sides of the magnet case should be of brass, and should be so arranged that they can be rotated about the axis of the needle, in order to bring the openings opposite the points. In any case, wherever glass must be used in magnetic instruments, it should contain a large percentage of lead.—E. G. Fischer, Terr. Magnetism, March, 1900.

Glaze for Greased Leathers.—For the preparation of a polish for greased leather, especially black grained and smooth calfskins, kips, neat's leather, and horse leather, W. Eitner gives the following directions:

Two hundred grammes of ruby shellac with 1 liter of spirit (95 per cent.) are let stand in a well closed vessel in a warm spot two to three days, shaking daily until same has dissolved.

Also dissolve 25 grammes of dry Marseilles soap in 375 cubic centimeters of heated spirit (95 per cent.) and pour to the solution 40 grammes of glycerin, shake thoroughly and introduce this mixture into the shellac solution, prepared a few days before.

In order to give the glaze a nice black color, dissolve 5 grammes spirit-soluble of nigrosin in 125 cubic centimeters of spirit and add this to the other mixture, close the vessel, carefully agitate thoroughly and leave the glaze stand at a warm place from 10 to 18 days before use.—Der Gerber.

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